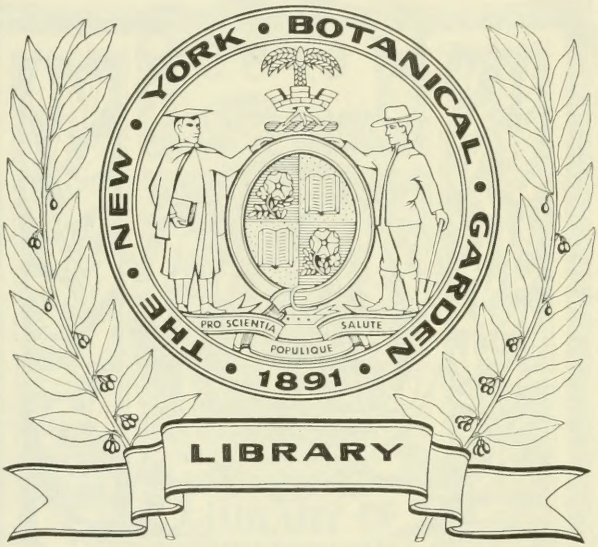
THE GRASSES AND GRASSLANDS OF SOUTH AFRICA

J. W. BEWS, M.A., D.Sc.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THE
GRASSES AND GRASSLANDS
OF
SOUTH AFRICA

BY

J. W. BEWS, M.A., D.Sc.

Professor of Botany in the Natal University College,
Pietermaritzburg

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WESTERN REGION
BECHUANALAND
Kalahari
SAND VELD REGION
GRASSVELD REGION
EASTERN
KARROID
CENTRAL
REGION
SOUTH WESTERN OR CAPE REGION
Limpopo R.
Pretoria
Johannesburg
Lourenco Marques
Vaal R.
Kuruman
Fontein Streams
Kimberley
Bloemfontein
Orange River
GRIQUALAND WEST
GRIQUALAND EAST
Caledon R.
Ficksburg
Durban
Prieska
Hopetown
Colesberg
Carnarvon
Victoria West
Richmond
Middelburg
Graaff Reinet
Prince Albert
Oudtshoorn
George
CAPE TOWN
Port Elizabeth
East London
Grahamstown
Humansdorp
THE GRASS REGIONS
OF
SOUTH AFRICA.
SCALE
100
0
100
200
300 miles

Preface.

The following pages have been written as a preliminary contribution to a very big and important subject. Various studies in South African plant ecology have been made during the past eight years, and to begin with it was my intention to add another to the series of papers, which I have published on this subject, namely, one dealing with the plant succession in the grasslands of South Africa. A grant towards travelling expenses was made by the Royal Society of South Africa. Various preliminary difficulties had first to be overcome, among which the chief one was the devising of a simpler means of identifying the 500 odd species of grasses, which occur in South Africa. The Key as first drawn up, was not intended to be published, but when I had distributed a few manuscript copies, it was urged by several of those who received them that the key should be included in the publication since it would prove useful to others. It is hoped that this will be the case, and at any rate it may be of assistance to those who are not in possession of the more elaborate treatise by Dr. Stapf in the Flora Capensis.

It soon became clear as the work progressed, that many important economic questions were involved, and detailed reference to these added to the length of the paper, so that for various reasons it was thought desirable to publish it in book form rather than in one of the scientific journals, especially since, under the present abnormal conditions, the sending of manuscript overseas leads to very long delays.

I have to express my indebtedness to Mr. C. G. Smith, of Durban, who has made a generous grant towards the cost of publication.

To two of my students, Miss M. Batchelor and Miss K. Jameson, my thanks are also due for doing most of the work in connection with the preparation of the illustrations. The map was prepared by Mr. R. Walker.

It is too much to expect that a work of this kind will be free from mistakes, and I hope that readers will help me by pointing out any corrections that should be made, or by offering suggestions for the improvement of the key.

Since, in the key to the species, and in the section of ecological notes the genera are arranged alphabetically, and a full table of contents is given for the sections dealing with the plant succession and economic applications, it has not been thought necessary to add an index.

J. W. BEWS.

Natal University College, July, 1918.

Contents.

Introduction.

The grasses belong to the family of the Poaceae or Gramineae, a well-defined natural group of plants. They are found all over the world, and altogether over 3,000 species are known. In South Africa there are about 500 species, a few of which have been introduced since the advent of the white settler. From the economic standpoint no family of plants is of greater importance since the Gramineae include the cultivated cereals, and the natural grasses are the chief food of stock in a pastoral country such as South Africa. The study of the individual species is not simple even for the expert, since they are separated by somewhat artificial characters, and the tribes into which they are divided are not well defined. On the other hand the collections of South African grasses that have been made are remarkably complete as compared with some other families. The earliest collections were made by Ecklon, Zeyher and Drège, and these were worked up and descriptions were published by Nees in 1841. Since that time many new species have been discovered, and the whole group has been thoroughly revised, and careful descriptions of the individual species have been given by Dr. Stapf in the Flora Capensis. Medley Wood in "Natal Plants" has given illustrations of 200 species, but he added little to Dr. Stapf's descriptions. Stapf has also written an interesting phytogeographical sketch of the distribution of the various genera and tribes in the separate regions of South Africa.[1]

Though these works have been available for many years, there are very few in South Africa who are familiar with the grasses. Students of Botany, I find, experience great difficulties in making use of the key to the genera given in the Flora Capensis, not that the work differs in that respect from other similar manuals. Many of the statements in all such keys are found on close inspection to be vague and contradictory. When I began a study of the plant succession in the grasslands of South Africa, I became convinced of the necessity of devising a simpler means of recognising the different grasses, and consequently the artificial key which is given here was drawn up. The nomenclature adopted throughout is that of the Flora Capensis, since a work of this kind is hardly the place where any revision of nomenclature should be undertaken.

1. Stapf, O. "Die Gliederung der Gräserflora von Südafrica." Festchrift Ascherson, Berlin, 1904.

To make the key as useful as possible to the reader, who is not familiar with botanical terms, a glossary is added, and the following elementary description of the structure of grasses is given. (See also Figs. 1 and 2.)

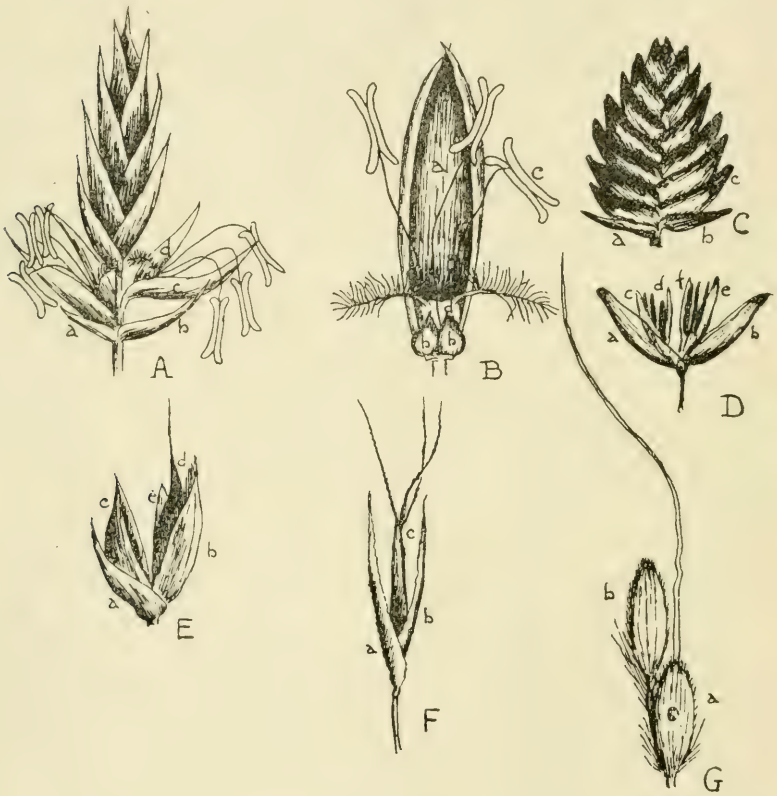

Fig. 1.—B. *Festuca elatior.* Spikelet with two lower florets opened out. *a* Lower glume. *b* Upper glume. *c* Valve. *d* Pale. *B. Festuca elatior.* Floret with Valve removed. *a* Pale. *b* Lodicules. *c* Stamen. *d* Ovary with two feathery styles. C. *Eragrostis superba.* Spikelet. *a* Lower glume. *b* Upper glume. *c* Valve. Numerous florets in the spikelet far exserted from the glumes. D. *Achneria capensis.* Spikelet. *a* Lower glume. *b* Upper glume. *c* Valve of lower floret. *d* Pale of lower floret. *e* Valve of upper floret. *f* Pale of upper floret. Two florets enclosed in the glumes. E. *Axonopus semialatus* var. *ecklonii.* Spikelet. *a* Lower glume. *b* Upper glume. *c* Valve of male floret, *d* Valve of the perfect floret. *e* Pale. Only one perfect floret, with one male floret below it. F. *Aristida bipartita.* Spikelet. *a* Lower glume. *b* Upper glume. *c* Valve with 3 branched awn. Only a single floret in the spikelet. G. *Andropogon pertusus.* *a* Sessile floret with lower glume pitted. Awned. *b* Pedicelled floret usually male. Awnless. (Figs A. and B. after Strasburger).

The ultimate branch of the inflorescence of a grass is the *spikelet* which is either borne on a stalk (or *pedicel*) or if there is no stalk is said to be *sessile*. It consists of an axis, known as the *rachilla*, which bears modified leaves or *bracts* arranged alternately. The lowest two bracts have no flowers in their axils and are known as *glumes*, the succeeding bracts have flowers, and are known as *valves*.

There are, however, the following occasional variations: (1) one or both the glumes may be absent or minute, and (2) one or more of the valves may have the flower imperfect or absent altogether. In the latter case the valve resembles a glume and is said to be *empty* or *barren*.

Either the glumes or the valves may be prolonged downwards at the point of their insertion on the rachilla into a *callus*.

Either the glumes or the valves or both may be prolonged upwards into a short *mucro* or longer *awn*.

Between each valve and the axis there is another bract called the *pale* which is sometimes small or absent. The flower is borne between the valve and the pale.

The separation of the different species depends chiefly on the characters of the glumes and valves, and the mode of arrangement of the spikelets in the inflorescence, but sometimes the characters of the flowers or seed are of importance.

The perfect (or *hermaphrodite*) flower consists of two minute scales called the *lodicules*, usually 3 *stamens* (rarely 1, 2, 4, or 6), and a single *ovary*. Each stamen consists of an *anther*, borne on a slender *filament*. The ovary bears two feathery *styles* (rarely 1 or 3).

Male flowers have stamens only. *Female* flowers have the ovary only.

The fruit (or so-called seed) is called a *caryopsis*, and has the seed coat adhering to the fruit wall. In a few cases the seed is free inside the fruit wall, and the fruit is called a *utricle*. The flowering axis is the *culm*. In perennial grasses there are *innovation shoots* which grow into culms in the second year. The innovation shoots either pierce the subtending leaf sheath, and grow up outside it (extravaginal), or they grow up between it and the culm (intravaginal). This feature is important in connection with plant succession and in the study of the effects of grass burning, etc.

The leaves are arranged alternately in two rows (2 ranked) and when perfect consist of (1) a *sheath* with its margins overlapping or grown together surrounding the culm, (2) a *blade*, and (3) a *ligule*, which is placed transversely at the inside of the junction of the sheath and blade.

Fig. 2.—Forms of inflorescence. A. *Oropetium capense*, a portion of a simple spike. B. *Harpechloa capensis*, a single secund spike. C. *Eleusine indica*, secund spikes. D. *Setaria perennis*, a panicle (false spike). E *Andropogon hirtus*, a single pair of racemes from the panicle. F. *Sporobolus festivus*, var. *stuppeus*. A portion of the panicle (A. magnified, the others slightly reduced).

The inflorescence consists of (1) a *spike* if the spikelets are not stalked (sessile), or (2) a *raceme* if the spikelets (or

some of the spikelets) are stalked, or (3) a *panicle* if the main axis is repeatedly branched bearing racemes laterally.

The identification of grasses is quite impossible unless the dissection is proceeded with in the proper way. Very little apparatus is required. A cheap mounted lens costing a few shillings is necessary. It should be placed over a glass plate, on which it is convenient to have the measuring scale in lines (equal to 1-12th of an inch) scratched out or etched. The spikelets should be dissected by means of two mounted needles (or large unmounted darning needles will serve) in a drop of water, and the characters of the separate parts noted as they are removed. Special care should be taken with the nerves or veins in the glumes and valves. These are sometimes faint, and can only be seen when the part is immersed in a drop of water.

In the sections where the environmental or *ecological* relationships of the grasses, and the development of (or plant succession in) the grassland types of vegetation are dealt with, certain other terms are used, and a brief introduction to this section is also necessary. The most recent work on this important aspect of botanical science is a book on "Plant Succession" by F. E. Clements, by consulting which fuller details may be learned. His system of nomenclature is adopted as far as has been found convenient. The important idea that must be grasped at the outset is that the *development* of the vegetation must be studied, and it is only in so far as we understand it fully that light will be thrown on many extremely important economic problems. The composition of grass veld, as farmers know well, is very apt to change, and it is one of the chief objects of this work to endeavour to explain, at least to a certain extent, what are the underlying causes which bring about such changes. The effects of grass burning, for instance, can only be properly understood if the detailed plant succession in the veld has been carefully studied.

The **Formation** is the final phase of a succession, or *climax* plant community over a natural area, in which the essential climatic conditions are similar or identical. Examples of plant formation in South Africa are:—(1) the Macchia of the South-Western portion of the sub-continent consisting chiefly of hard-leaved (sclerophyllous) shrubs. It occurs also at higher altitudes along the Drakensberg. In it a large number of drought-resisting (xerophytic) grasses are present, but they occur in isolated tufts, or small patches, and

are nowhere dominant, (2) open grassland formation of the Western side, much of it semi-desert, (3) the Karroo, (4) the Sand Veld of the Kalahari, (5) the Grassveld of Eastern Cape Colony, Natal, the Eastern part of the Free State, and the Transvaal, a widely extended type of formation of which there are several sub-types or varieties which may or may not be considered sufficiently distinct to rank as separate formations. (This type will often be referred to in the following pages as "the grass veld of the Eastern side" or "Eastern grass veld"). (6) Succulent and Thorny Scrub of the dry river valleys—the climax of Thorn Veld, (7) Forest.

The **Association** is a climax community with two or more dominants, *e.g.*, a Yellow-wood-Black Ironwood forest. The Associations are units which are associated regionally to constitute the formation.

The **Consociation** is the unit of the association characterised by a single dominant, *e.g.*, Falcate Yellow-wood forest or *Anthistiria* (red grass or insinde) veld.

The **Society** is a climax community characterised by a sub-dominant, or sometimes by two or more sub-dominant species. Societies of various species of the large grass genus *Andropogon* are very common in much of our eastern grass veld. The society is a localised or recurrent dominance within a dominance. Clements distinguishes (1) *Aspect Societies* which dominate only for a season, *e.g.*, in spring, and are replaced later by other societies. We thus find Prevernal, Vernal, Aestival, and Autumnal aspect societies. Of these the vernal and aestival are of most importance in South African grass veld. (2) *Layer Societies* very conspicuous in woodland but occurring in grassland also. The different types of vegetation are arranged in layers, and the development is usually seasonal as in the aspect societies. (3) *Cryptogamic Societies* consisting of lower forms of plant life such as the Mosses.

The **Clan** ranks below the society in importance, but there is no hard and fast line to be drawn between them. The clan is local or restricted to a few scattered areas.

It is necessary to lay emphasis on the fact that all the above are climax communities, belonging to the final stage of the plant succession.

Throughout the succession there are similar or analagous communities, which do not belong to the climax stage, but

prepare the way for other communities which succeed them. For these Clements proposes other terms, *viz.*, **Associes**, **Consocies**, and **Socies**, these being the developmental or seral equivalents of Association, Consociation and Society. Further a **Colony** is a pioneer or initial community of two or more species, and a **Family** according to Clements, in the ecological sense is a group of individuals belonging to a single species, which usually soon becomes converted into a colony. This last term is likely to lead to confusion, since it is also used in another sense, so it will not probably be generally adopted.

Instead of using the term "succession" both in a concrete and in an abstract sense, Clements uses the word *Sere* as a term for a definite single or unit plant succession. It comprises the development of a formation from the appearance of the first pioneers through all the stages to the climax. The various successions are further divided into Primary and Secondary with the corresponding terms *Prisere* and *Sub-sere*. *Priseres* are the main regional successions, and their analysis is not always easy. *Sub-seres* are confined to bare areas due to superficial disturbance, and are largely due to man's interference. For example: the succession from abandoned cultivated land back to grassveld is a Sub-sere, as is also regeneration in a burnt-out forest. The Sub-seres are much more numerous and more easily investigated than the Priseres.

Priseres and Sub-seres are further sub-divided according to the nature of the extreme area which is colonised by the initial or pioneer communities, into (1) a *Hydrosere* which begins in wet places such as Vleis, and (2) a *Xerosere* which begins in dry places. There are other proposed terms, *viz.*, *Halosere* for salt water, *Oxysere* for acid water, and the Xerosere may be divided into *Lithosere* for rock surfaces, and *Psammosere* for sandy areas.

Glossary of Botanical Terms.

Acuminate—tapering to a long point.
Acute—simply pointed.
Adnate—growing to or upon something else.
Amplexicaul—stem clasping.
Anastomosing—joining up of veins.
Aphyllous—leafless.
Aristate—awned.
Aristulate—with a small awn.
Articulate—jointed.
Ascending—rising upwards as a stem.
Auriculate—ear-shaped.

Caducous—falling off.
Caespitose—growing in tufts.
Capillary—hair like.
Capitate—head shaped, with a head.
Caudate—tailed, with a tail.
Chartaceous—paper-like, papery.
Chlorenchyma—tissue with green chlorophyll.
Ciliate—fringed with Cilia, as with eye lashes.
Clavate—club-shaped, thickened upwards.
Conduplicate—simply folded.
Connate—united or growing together.
Convolute—inrolled.
Cordate—heart-shaped, with rounded lobes at the base.
Coriaceous—leathery, leather-like.
Crustaceous—slightly brittle.
Cuneate—wedge-shaped.
Cuspidate—tipped with a short rigid point.

Decumbent—reclining with the summit ascending.
Decurrent—running down.
Deltoid—in the form of an equilateral triangle.
Dentate—toothed, teeth pointing outwards.
Denticulate—minutely toothed.
Dichotomous—with forked branching.
Diffuse—loosely spreading.
Digitate—arranged like the fingers of a hand.
Distichous—having two rows.
Divaricate—widely spreading apart.
Divergent—spreading in different directions.
Dorsal—pertaining to the back.

Effuse—loosely spreading.
Eglandular—without glands.
Emarginate—having a notched apex.
Erect—upright, perpendicular.
Evanescent—lasting only for a short time.
Excurrent—running out.
Exserted—projecting beyond.

Fascicled—in close clusters or bundles.
Fastigiate—with parallel erect clustered branches.
Filiform—shaped like threads.
Fimbriate—with a fringed margin.
Flabellate—fan-shaped.
Fugacious—falling off or fading early.
Fusiform—tapering at both ends.

Geniculate—kneed and bent.
Gibbous—humped or pouched.
Girders—supporting bands of Sclerenchyma running in the principal ribs and ridges of a leaf.
Glabrous—without hairs.
Glabrescent—becoming hairless.
Glandulose—with glands.
Glaucous—of a grey blue colour.

Halophilous—salt loving.
Halophytes—plants growing in brackish soils.

Heteromorphous—of more than one kind or form.
Hilum—scar on seed where formerly attached, a posterior mark on the grain (caryopsis) of a grass.
Hirsute—rough, hairy, with long distinct hairs.
Hispid—with stiff hairs or bristles.
Hyaline—glass-like, transparent.
Hydrophilous—water loving.
Hydrophytes—water plants.
Hygrophilous—moisture loving.
Hygrophytes—plants growing in moist places.

Imbricate—overlapping.
Involucre—a covering of bracts.
Involute—rolled inwards.

Lanceolate—narrow, and tapering at both ends.
Lax—loose, spikelets some distance apart.
Linear—at least five times as long as broad, with parallel straight sides.

Membranous—having the texture of fine membranes.
Mesophytes—plants adapted to fairly moist conditions.
Mucronate—with a short point (mucro) suddenly springing from a rounded apex.
Mucronulate—with a little mucro.
Muricate—full of rough, short, sharp points.
Muticous—curtailed, blunt, awnless.

Obtuse—blunt and rounded at the apex.
Ovate—elliptic but broader at the base.

Pectinate—like the teeth of a comb.
Peduncle—stalk of flower or inflorescence.
Penicillate—brush-like, or pencil shaped.
Pericarp—fruit coat.
Pilose—thinly covered with long soft hairs.
Plicate—folded like a closed fan.
Plumose—feathery plumed.
Praemorse—as though the end were bitten off.
Procumbent—lying along the ground.
Pruinose—having a waxy bloom on the surface.
Psammophytes—sand plants.
Pubescent—slightly hairy.
Punctate—marked with dots.
Punctiform—like a dot.
Pungent—pointed, piercing.

Radical—belonging to or arising from the root.
Reflexed—abruptly bent back.
Retuse—blunted with a slight notch at the rounded apex.
Revolute—rolled back from the margin or apex.
Rhizome—an underground stem.
Rigid—stiff, inflexible.
Ruderal—growing in waste places.
Rufous—reddish.
Rugose—wrinkled.

Sagittate—with lobes at the base pointed like an arrow head.
Sarmentose—bearing long slender runners.
Scabrid—rough to the touch.
Scaberulous—somewhat rough.
Scarious—dry and membranous, not green.
Sclerophyllous—with hard stiff leaves.
Sclerosed—hardened, lignified.
Sclerenchyma—hardened fibrous tissue.
Secund—one-sided, on one side.
Serrate—beset with saw teeth. Teeth pointing forwards.
Setaceous—like coarse bristles. (**Seta**—a bristle.)
Setose—bristly, beset with bristles.
Sessile—without a stalk.
Sinus—a deep notch or recess.
Spathe—a large bract enclosing a flower cluster.

Spicate—disposed on a spike.
Spiciform—like a spike.
Spinescent—ending in a spine.
Stellate—star-like.
Stipitate—having small stalks.
Stoloniferous—having suckers or runners (Stolons).
Striate—with fine longitudinal parallel veins.
Strigose—closely covered with bristles.
Subulate—awl shaped; stouter than setaceous.
Suffrutescent—somewhat like a shrub.
Sulcate—grooved, furrowed, or fluted.
Supine—prostrate.

Terete—cylindrical, circular in cross section.
Testa—seed coat.
Thyrsoid—a compact inflorescence, thicker at the middle and tapering at both ends.
Tomentose—densely covered with short soft tangled hairs.
Trichotomous—with divisions in threes.
Trigonous—three angled, three-cornered.
Trimerous—in three parts, or parts in threes.
Truncate—ending abruptly as if cut off.
Tuberculate—beset with small knobby projections.
Turgid—swollen, but not hollow.

Umbelled—arising near one point, in an umbel.

Ventral—pertaining to the front.
Villose or **Villous**—shaggy, with long soft hairs not interwoven.
Viscous—**Viscid**—sticky.
Viviparous — producing young plants instead of seed.

Xerophilous—adapted to withstanding drought.
Xerophytes—plants which live under dry conditions.

II.—Key to the Genera and Species of South African Grasses.

1. (a). Spikelets all sessile singly or in clusters in the notches of a simple spike, not all on one side of the rachis (secund) (Tribe Hordeae). See Fig. 2 A. ... 2
   (b). Spikelets sessile or slightly pedicellate, all on one side of the rachis (secund). See Fig. 2 B. and C. 7
   (c). Spikelets neither in the notches of a simple spike nor secund. See Fig. 2 D., E., and F. 26
2. Two or more spikelets at each node of the spike. **Hordeum.**
   Spikelets solitary at the nodes of the spike 3
3. Side of the spikelet towards the rachis 4
   Edge of spikelet towards the rachis. Lower glume minute or 0. 5
4. Glumes subulate, 1 nerved ... ... **Secale africanum.**
   Glumes not subulate, many nerved ... ... **Agropyrum distichum.**
5. Flowers 3-many in the spikelet. Valves 5-7 nerved. **Lolium.**
   Flowers 1-3 in the spikelet. Valves 1-3 nerved 6
6. Upper glume 5-7 nerved ... ... **Lepturus cylindricus.**
   Upper glume 3 nerved ... ... **Oropetium capense.**
7. Two empty valves between the glumes and the perfect florets. Spikelets falling entire with the glumes... 8
   1-0 empty valves between the glumes and the perfect florets, or if 2 barren florets occur (Ctenium) then the glumes persistent 9
8. Glumes and empty valves one nerved... **Tetrachne dregei.**
   Glumes and empty valves more than one nerved. **Entoplocamia aristulata.**
9. Valves one nerved. Strand plant ... ... **Spartina stricta.**
   Valves more than one nerved 10
10. Spikelets falling entire. Lower glume smaller or 0. Glumes not keeled 11
    Lower glume persistent, distinct and keeled. Upper glume sometimes falling with the spikelet 14
11. Spikelets sunk in hollows or adpressed to the face of a broad rachis. Stem creeping. **Stenotaphrum glabrum.**
    Spikelets not sunk in hollows on a broad rachis 12

12. Lower glume distinct (See also 55) ... ... **Panicum.**
Lower glume minute or 0. 13
13. Nerves of lower value 5-7 close straight and prominent. Lower glume usually present but minute. **Digitaria.**
Nerves of lower valve 5 or fewer. Side nerves curved and usually submarginal. Lower glume absent. **Paspalum.**
14. Spikelets 1 flowered. No male or barren florets ... 15
Spikelets with more than 1 perfect floret, or with 1 perfect and 1 or more male or barren florets 16
15. Glumes shorter than the glabrous valve ... ... **Cynodon.**
Glumes longer than the ciliate valve ... ... **Microchloa.**
16. Spikelets with 1 perfect and 1 or more male or barren or rudimentary florets 17
Spikelets with 2 or more perfect florets 20
17. More than one spike in the inflorescence ... ... **Chloris.**
Spike solitary 18
18. Spikelets awned ... ... **Ctenium concinnum.**
Spikelets awnless 19
19. Upper glume much longer than the lower ... ... **Harpechloa capensis.**
Lower glume slightly longer than the upper ... **Microchloa altera** var. **nelsoni.**
20. False spikes numerous, arranged spirally 21
Spikes or false spikes solitary or umbelled, sometimes with 2 below the umbel 23
21. Valves minutely notched. (See also 88) ... ... **Diplachne.**
Valves entire 22
22. Tips of rachilla joints fringed with minute hairs. **Pogonarthria falcata.**
Tips of rachilla joints not fringed. (See also 88). **Eragrostis.**
23. Inflorescence a single false spike 24
More than one spike in the inflorescence 25
24. Spikelets 2 flowered ... ... **Prionanthium pholiuroides.**
Spikelets 4-9 flowered. (See also 113) ... ... **Brizopyrum.**
25. Spikes terminated by a spikelet ... ... **Eleusine.**
Point of the rachis of the spike naked, projecting. **Dactyloctenium aegyptiacum.**
26. Spikelets with 1 perfect floret, with or without 1 or more male or barren florets, or empty valves, **below** it... 27
Spikelets with 2 or more perfect florets or very rarely with only 1 perfect floret, which has male or barren florets or empty valves **above** it 71

27. Spikelets in pairs, usually one sessile, the other pedicelled, the latter sometimes rudimentary. Lower glume rigid and longer than the florets. (Trib. Andropogoneae) 28
Spikelets either not in pairs or if in pairs then the lower glume not rigid and shorter than the florets ... 39
28. Spikelets all alike or differing only in the lower glume 29
The two spikelets of each pair differing in sex and structure 33
29. Racemes in a panicle 30
Racemes 2 nate, digitate or fascicled 32
30. Spikelets awned ... ... **Erianthus.**
Spikelets awnless 31
31. Panicle silky, spiciform. Rachis not fragile ... ...
Imperata arundinacea.
Panicle silky, much branched. Rachis fragile ...
Saccharum munroanum.
32. The two spikelets of each pair alike in all respects.
Pollinia.
The two spikelets of each pair differing in the lower glumes ... ... **Ischaemum.**
33. Sessile spikelets sunk in hollows 34
Sessile spikelets not sunk in hollows 35
34. All the spikelets awnless **Rottboellia compressa** var. **fasciculata.**
Pedicelled spikelets awned ... ... **Urelytrum squarrosum.**
35. Lower floret of sessile spikelet always male ... ...
Ischaemum glaucostachyum.
Lower floret of all spikelets empty 36
36. All the spikelets awnless ... ... **Elionurus argenteus.**
Spikelets not all awnless 37
37. 1-3 pairs of perfect and male spikelets subtended by a whorl of male or barren spikelets, and the whole supported by a spathe ... ... **Anthistiria imberbis.**
No whorl of male or barren spikelets at the base ... 38
38. Sub-sessile spikelets awnless. Pedicelled awned.
Trachypogon polymorphus.
Sessile spikelets awned ... ... **Andropogon.**
39. Blades transversely veined. Flowers unisexual.
Olyra latifolia.
Blades not transversely veined 40
40. Glumes 0 or very minute (Tribe Oryzeae) 41
Glumes 2 distinct, or rarely lower glume absent, and upper distinct 42

41. Two minute nerveless valves below the floret. Bush grass ... ... **Potamophila prehensilis.**
No empty valves. Fruiting valves ciliate. Vlei grass ... **Leersia hexandra.**
42. One or more empty valves or male florets below the fertile floret 43
A single fertile floret only. No empty valves 56
43. Two empty valves (sometimes minute), or 2 male or barren florets below the fertile floret 44
One empty valve or male floret below the fertile floret 46
44. Lower (empty or male) valves awned dorsally. Awns kneed ... ... **Anthoxanthum.**
Valves awnless or awned from the tip. Awns straight 45
45. Empty valves minute, enclosed by the glumes ... **Phalaris.**
At least one of the empty valves larger than the fertile ... **Ehrharta.**
46. Glumes not falling with the spikelet (Tribe Arundinelleae) 47
Spikelets falling entire with the glumes (Tribe Paniceae) 49
47. Spikelets in clusters of three, large ... ... **Tristachya.**
Spikelets solitary 48
48. Spikelets less than $\frac{1}{5}$ inch. Upper valve minutely 2 toothed or entire ... ... **Arundinella ecklonii.**
Spikelets $\frac{1}{6}$-$1\frac{1}{2}$ inches. Upper valve distinctly 2 toothed or 2 lobed ... ... **Trichopteryx.**
49. Spikelets subtended by bristles (1 or many) 50
Spikelets not subtended by bristles 51
50. Bristles persistent ... ... **Setaria.**
Bristles falling off with the spikelet ... ... **Pennisetum.**
51. Glumes or lower valve 2 lobed or emarginate, muticous or awned from the sinus. Lower glume minute or 0 52
Glumes and lower valve entire, awnless or awned. Lower glume distinct 53
52. Upper glume 5 nerved, tips obtuse ... ... **Tricholaena.**
Upper glume 7 nerved, tips acute ... ... **Melinis minutiflora** var. **pilosa.**
53. Spikelets in deciduous clusters, with a false involucre of the lower glumes ... ... **Anthephora.**
Spikelets falling singly 54
54. Glumes subequal, long awned. Awns viscous, cylindrical ... ... **Oplismenus africanus.**
Glumes usually unequal, awnless or shortly awned. Awns scabrid 55

55. Inflorescence of 2-5 stout racemes ... ...
Axonopus semialatus var. **ecklonii.**
Inflorescence a loose (rarely contracted) panicle. (See also 12) ... ... **Panicum.**

56. Glumes awned 57
Glumes awnless or shortly mucronate 59

57. Valve 1 nerved ... ... **Perotis latifolia.**
Valve more than 1 nerved 58

58. Glumes persistent, gradually passing into the awn. (See also 64) ... ... **Agrostis polypogonoides.**
Glumes deciduous, emarginate, with an awn from the sinus ... ... **Polypogon.**

59. Valves awned 60
Valves awnless 66

60. Awns of valve 3, or 3 branched ... ... **Aristida.**
Awns of valve solitary 61

61. Floret exserted from the glumes **Pseudobromus africanus.**
Floret not exserted from the glumes 62

62. Nerves of valve parallel, not joining at the tip, often slightly excurrent 63
Nerves of valve closely approaching or joining at the tip 65

63. Glumes covered with long soft hairs ... **Lagurus ovatus.**
Glumes not covered with long soft hairs 64

64. Valve decurrent into a callus, which has hairs several times longer than the valve itself ... ...
Calamagrostis epigeios var. **capensis.**
Callus glabrous or minutely hairy. (See also 58 and 70)...
Agrostis.

65. Awn kneed ... ... **Stipa.**
Awn straight or 0 ... ... **Oryzopsis miliacea.**

66. Lower glume minute or 0. Upper glume with hooked spines or bristles ... ... **Tragus.**
Both glumes distinct, not spiny nor with bristles ... 67

67. Valve decurrent into a callus, which is conspicuously hairy ... ... **Ammophila arundinacea.**
Callus, if present, not conspicuously hairy 68

68. Valve more than 3 nerved 69
Valve 3-1 nerved 70

69. Valve faintly 7 nerved, silky villous. **Poagrostis pusilla.**
Valve faintly 5 nerved, smooth. (See also 64) ...
Agrostis verticillata.

70. Valve muticous or mucronate, usually hairy. Glumes subequal, longer than the floret. (See also 64) ... **Agrostis lachnantha.**
Valve not as in 70. At least one of the glumes shorter than the floret ... ... **Sporobolus.**
71. Tall reed grasses, growing in or near water (Tribe Arundineae) 72
Not reed grasses 73
72. Lowest floret like the rest, hairy from the back of the valve ... ... **Arundo donax.**
Lowest floref male or barren, hairy from the long slender callus only ... ... **Phragmites communis.**
73. Blades transversely veined (Tribe Bambuseae) ... **Arundinaria tesselata.**
Blades not transversely veined 74
74. Valves cleft into 4 or 9 lobes (Tribe Pappophoreae) ... 75
Valves not cleft into 4 or 9 lobes 76
75. Valves cleft into 4 lobes with 5 awns from the sinuses ... **Schmidtia bulbosa.**
Valves cleft into 9 subulate, awn like lobes. **Enneapogon.**
76. Spikelets of 2 kinds, fertile surrounded by sterile consisting solely of bracts 77
Spikelets not of 2 kinds, etc. 78
77. Barren bracts obtuse, membranous ... **Lamarckia aurea.**
Barren bracts very narrow, rigid, acute or awned ... **Cynosurus echinatus.**
78. Lower 1 or 2 florets fertile, upper 2-3 valves empty, enclosing each other forming a club or spindle shaped body ... ... **Melica.**
No club or spindle shaped body 79
79. Valves 3 nerved 80
Valves 5-11 nerved 91
80. Whole panicle dense, cylindrical, and usually dark purple. Glumes. valves, and pales equally hairy all over ... ... **Stiburus alopecuroides.**
Glumes, valves, and pales not all equally hairy, etc.... 81
81. Valves awned or mucronate 82
Valves awnless and not mucronate 87
82. Lowest 2 florets fertile, upper 2-4 barren, forming a tuft of awns ... ... **Lophacme digitata.**
No tuft of barren awns at the top 83
83. Lower floret awnless. Valve of upper floret with a bent awn. (See also 94) ... ... **Holcus.**
Awns straight 84

84. Side nerves of the valve excurrent into bristles ... **Triraphis.**
Side nerves of the valve not excurrent into bristles... 85
85. Branches of panicle very rigid and spreading. Spikelets distant by more than their own length ... ... **Crossotropis grandiglumis.**
Spikelets not distant by more than their own length... 86
86. Valves 2 toothed. Awn from the back. (See also 88) ... **Diplachne.**
Valves minutely 4 toothed. Awn terminal ... ... **Leptocarydium vulpiastrum.**
87. Side nerves of the valve submarginal. Florets usually numerous and far exserted from the glumes ... 88
Side nerves of the valve delicate and not submarginal. Florets 2 or 3 with uppermost reduced. Shorter than or not much longer than the glumes 89
88. Valve entire ... ... **Eragrostis.**
Valve minutely notched, or with 2 lateral teeth. **Diplachne.**
89. Keel of glume with pectinate teeth. (See also 24) ... **Prionanthium.**
Keel of glume not with pectinate teeth 90
90. Glumes unequal. Florets 2-3. (See also 109) ... **Koeleria cristata.**
Glumes sub-equal. Florets 2. (See also 112, 114) ... **Achneria.**
91. Panicle small, falling as a whole together with the subtending sheath ... ... **Urochlaena pusilla.**
Inflorescence not deciduous as a whole 92
92. Spikelets deciduous as a whole, with the glumes ... 93
Spikelets breaking up, leaving glumes persistent ... 95
93. Glumes 5-9 nerved ... ... **Chaetobromus.**
Glumes 1-3 nerved 94
94. Lower glume 1 nerved, upper 3 nerved. (See also 83) ... **Holcus.**
Both glumes 1 nerved ... ... **Fingerhuthia.**
95. Valves awned from the back near the middle (sometimes awnless in Aira) 96
Valves awnless or awned. Awns if present terminal, or subterminal, below the tip, or from a sinus 98
96. Spikelets large or very large. Glumes rounded on the back 7-11 nerved ... ... **Avena.**
Spikelets medium sized to small. Glumes more or less keeled. 1-3 rarely—7 nerved 97

97. Florets 2. Valves shorter than the glumes ... ... **Aira caryophyllea.**
Florets 3-6. Valves exserted from the glumes ... **Avenastrum.**
98. Styles distinctly lateral on a hairy 2-3 lobed appendage of the ovary. Spikelets rather large ... ... **Bromus.**
No hairy 2-3 lobed appendages on the top of the ovary 99
99. Valves 2 cleft or 2 lobed with or without an awn or mucro from the sinus 100
Valve entire or minutely bifid, awned or awnless ... 103
100. Florets 2 101
Florets more than 2, uppermost often reduced 102
101. Top of the ovary glabrous. Seed adnate to the thin pericarp ... ... **Pentaschistis.**
Top of the ovary hairy. Seeds free except along the hilum inside the crustaceous pericarp ... **Pentameris.**
102. Annual or subperennial. Uppermost of the 6-7 small florets exserted. Awn straight or 0 ... ... **Schismus.**
Perennial, very rarely annual. Florets exceeded by the glumes or more or less equalling them. Awn kneed or reduced to a mucro ... ... **Danthonia.**
103. Valves awned 104
Valves awnless (occasional spikelets in **Achneria setifolia** are awned) 110
104. Valves 7-9 nerved 105
Valves 5 nerved 106
105. Spikelets subsessile in a simple raceme or false spike ... **Brachypodium.**
Spikelets in open or contracted panicles. (See also 108 and 115) ... ... **Festuca.**
106. Glumes very unequal, lower sometimes obsolete. Awn of valve long ... ... **Vulpia.**
Glumes not very unequal. Awn of valve short or reduced to a mucro 107
107. Valves keeled and keel ciliate ... ... **Dactylis glomerata.**
Valves not keeled, or if keeled, then keel not ciliate... 108
108. Perennial. Panicle not spiciform ... ... **Festuca.**
Annual. Panicle spiciform 109
109. Rachilla glabrous or almost so ... ... **Koeleria phleoides.**
Rachilla ciliate ... ... **Trisetum pumilum.**
110. Spikelets in lax panicles or racemes, generally nodding on long capillary pedicels. Valves broadly cordate-ovate, boat shaped ... ... **Briza.**
Valves not broadly cordate-ovate, boat shaped, etc. 111

111. Panicle dense and spiciform, or spicate... 112
Panicle loose, or contracted and rigid, but not dense and spiciform 114
112. Glumes 1 (near the base rarely 3) nerved (See also 90 and 114) ... ... **Achneria.**
Glumes 4-7 nerved 113
113. Valves with acute hairs, not exserted from the glumes. **Lasiochloa..**
Valves usually with clavately tipped hairs, exserted from the glumes (See also 22) ... ... **Brizopyrum.**
114. Florets 2, not or not much exserted from the glumes. Panicle trichotomously divided. (See also 90 and 112). **Achneria.**
Florets 2—many uppermost often reduced, exserted from the glumes 115
115. Valves muticous or mucronulate, with nerves usually distinct. Hilum of the seed linear. (See also 105 and 108) ... ... **Festuca.**
Valves obtuse or rarely acute, with nerves rather faint. Hilum of the seed punctiform. (Tribe Poeae) ... 116
116. Panicle with very stiff rigid two ranked branches. Outer side nerves of the valve much more distinct than the faint inner ... ... **Scleropoa rigida.**
Panicle not stiff and rigid. Valves more or less equally though sometimes faintly nerved 117
117. Glumes and valves rounded on the back ... ... **Atropis.**
Glumes and valves keeled. Florets often with a tuft of wool at the base ... ... **Poa.**

KEY TO THE SPECIES NOT INCLUDED ABOVE.

(THE GENERA FOR CONVENIENCE ARE ARRANGED ALPHABETICALLY.)

ACHNERIA.

1. Panicle very dense to compact; branches extremely short 2
   Panicle trichotomous, loose; branchlets at least equal to ½ the panicle 3
2. Panicle 1-2½ in. long. Spikelets 1½-1¾ lin. long ... ... **A. ecklonii.**
   Panicle less than 1 inch long. Spikelets 1¼ lin. long. **A. curvifolia.**
3. Spikelets 1-1½ lin. long. Leaves not more than ½ inch long ... ... **A. microphylla.**
   Spikelets larger. Leaves longer 4
4. Glumes obtuse to sub-acute 5
   Glumes very acute to acutely acuminate 6
5. Glumes sub-acute. Valves prominently 9-11 nerved. **A. aurea.**
   Glumes obtuse. Valves obscurely 5 nerved. **A. capensis.**
6. Valves much shorter than the glumes ... **A. capillaris.**
   Valves equalling the glumes or nearly so 7
7. Culms many noded. Spikelets 1½-1¾ lin. long. **A. ampla.**
   Culms few noded. Spikelets 2-3½ lin. long 8
8. Panicle small. Spikelets 2-2½ lin. long. Blades setaceous. **A. setifolia.**
   Panicle 4-6 inches. Spikelets 2¾-3 lin. long. Blades not setaceous ... ... **A. hirsuta.**

AGROSTIS.

1. Spikelets ½-1 lin. long 2
   Spikelets 1½-2½ lin. long 3
2. Spikelets ½ lin. long. Glumes obtuse. Panicle dense. **A. griquensis.**
   Spikelets ¾-1 lin. long. Glumes acute. Panicle lax. **A. bergiana.**
3. Spikelets 1½ lin. long ... ... **A. schlechteri.**
   Spikelets about 2½ lin. long 4
4. Panicle, spike-like, lobed ... ... **A. natalensis.**
   Panicle lax 5
5. Panicle about 6 inches long ... ... **A. barbuligera.**
   Panicle about 11 inches or more long ... ... **A. suavis.**

ANDROPOGON.

1. Annual. (Kafir Corn and its varieties) ... **A. sorghum.**
   Perennial 2
2. Panicle large, effuse, nodding. Racemes numerous, all long pedicelled (similar to **A. sorghum** but perennial). **A. halepensis** var. **effusus.**
   Panicle smaller, not effuse and nodding, or if effuse then racemes fewer in number and 2 nate 3
3. Racemes solitary 4
   Racemes not solitary 6
4. Lowest 2-6 pairs of spikelets male and awnless. Upper sessile spikelets awned ... ... **A. contortus.**
   Lower sessile spikelets not differing from the upper 5
5. Racemes 7-8 lin. long. Joints of the rachis filiform. **A. ceresiaeformis.**
   Racemes 2-5 inches long. Joints of the rachis stout ... **A. hirtiflorus.**
6. Racemes silvery plumose, with hairs 5 lin. long ... **A. eucomus.**
   Racemes glabrous to silvery villous. Hairs never 5 lin. long 7
7. Racemes digitate, fascicled, or panicled, but not 2 nate 8
   Racemes 2 nate, terminal on the culms or on numerous branches 14
8. Lateral racemes sessile 9
   Racemes peduncled 10
9. Lower glumes dorsally flattened. Keels broadly winged above ... ... **A. distachyus.**
   Lower glumes dorsally concave. Keels not winged. **A. appendiculatus.**
10. Racemes 1 articulate (i.e. reduced to 1 sessile perfect and 2 pedicelled, male or barren spikelets) ... ... **A. monticola** var. **trinii.**
    Racemes not 1 articulate 11
11. Sessile spikelets alike in form, but differing in sex (Western spec) ... ... **A. annulatus.**
    Sessile spikelets alike in form and sex 12
12. Lower racemes shorter than the common rachis. Glumes pitted... ... ... **A. intermedius** var. **punctatus.**
    Lower racemes longer than the common rachis 13
13. Lower glumes of the sessile spikelets not pitted ... **A. ischaemum** var. **radicans.**
    Lower glumes of the sessile spikelets pitted. **A. pertusus.**

14. Racemes 2-9 inches long, on the main culms 15
Racemes $\frac{1}{3}$-1$\frac{1}{2}$ inches long, on branches of a panicle 19
15. Lower glumes dorsally flattened. Keels broadly winged above ... ... **A. distachyus.**
Lower glume with a narrow groove. Keels not winged 16
16. Blades very narrow, filiform ... ... **A. filifolius.**
Blades linear 1-5 lin. broad 17
17. Blades rounded or sub-cordate, and sub-amplexicaul at the base ... ... **A. amplectens.**
Blades narrow at the base 18
18. Culms simple. Blades 1-2 lin. broad ... ...
A. schirensis var. **angustifolia.**
Culms branched. Blades 2-3$\frac{1}{2}$ lin. broad ... **A. schinzii.**
19. Column of the awn glabrous 20
Column of the awn pubescent or hirsute 22
20. Leaf sheaths quite glabrous. Lower glume of sessile spikelets with a narrow groove from the middle downwards... ... ... **A. schoenanthus.**
Lower sheaths firm, fugaciously hairy to tomentose at the base.
Lower glume of the sessile spikelets flattened or concave... 21
21. Keels of lower glume winged above ... ...
A. nardus var. **marginatus.**
Keels of lower glume rounded. Scarcely winged ...
A. plurinodis.
22. Callus of the sessile spikelets very short or obscure, obtuse 23
Callus of the sessile spikelets acute, up to 1 lin. long, densely bearded 30
23. Spathes broadly lanceolate to ovate, $\frac{1}{2}$-1 inch long ...
A. cymbarius.
Spathes narrow linear to lanceolate, 1-3 inches long... 24
24. Spikelets of the lowest 2 pairs of peduncled racemes alike in form and sex ... ... **A. buchanani.**
Spikelets of the lowest pair of the peduncled raceme of different sex 25
25. Racemes short, 2-5 jointed ... ... **A. dichroos.**
Racemes long, 5- many jointed 26
26. Spikelets silvery villous 27
Spikelets not silvery villous 28
27. Tall stout culms. Common peduncles laterally exserted.
A. auctus.
Slender culms. Common peduncles equalling or exceeding the spathes ... ... **A. hirtus.**

28. Culms rather slender. Panicle narrow. Common peduncles curved ... ... **A. dregeanus.**
Culms stout. Panicle decompound. Common peduncles not so strongly curved 29
29. Common peduncles enclosed or laterally exserted. Hairs if present whitish ... ... **A. schimperi.**
Common peduncles usually long exserted. Hairs if present rufous ... ... **A. rufus.**
30. Hermaphrodite spikelets subtended by a bract-like appendage ... ... **A. ruprechti.**
No scarious bract-like appendage 31
31. Racemes 5-6 lin. long, each with 1 hermaphrodite spikelet ... ... **A. filipendulus.**
Racemes 6-12 lin. long, with more than 1 hermaphrodite spikelet 32
32. Culms simple. Racemes 6-8 lin. long ... **A. transvaalensis.**
Culms branched all along. Racemes about 1 inch long. **A. pleiarthron.**

ANTHEPHORA.

Perennial. Involucral glume minutely tubercled and villous outside. Lower valve 5-7 nerved ... **A. pubescens.**
Annual. Involucral glume glabrous except at the base. Lower valve 3 nerved ... ... **A. undulatifolia.**

ANTHOXANTHUM.

1. Panicle small or reduced to a scanty raceme. Culms and leaves very small, weak ... ... **A. tongo.**
Panicle spike-like. Culms erect, 1-3 feet long 2
2. Spikelets pallid, 4 lin. long. Lower glume 1 nerved ... **A. ecklonii.**
Spikelets greener, 3 lin. long. Lower glume 3 nerved ... **A. dregeanum.**

ARISTIDA.

1. Awns glabrous. Glumes 1 nerved 2
All or only the middle bristle of the awns plumose. Glumes 3 nerved 14
2. Awns disarticulating from the valve, distinctly stipitate 3
Awns not disarticulating, but sometimes jointed just below the branching point 6
3. Glumes aristulate. Foot of the awn 8-20 lin. long ... **A. sieberiana.**
Glumes not aristulate. Foot of the awn 1-6 lin. long 4

4. Ligule a line of very short hairs. Panicle 3-6 ins. long. Lower branches 1½-3 ins. long. Foot of the awn 1-2½ lin. long ... ... **A. vestita.**
Ligule a woolly fringe. Panicle 6-18 ins. long. Lower branches 4-8 ins. long. Foot of the awn 2½-6 lin. long 5
5. Glumes sub-equal; foot of the awn 2½ lin. long ... **A. spectabilis.**
Glumes very unequal; foot of the awn 2½-6 lin. long ... **A. stipoides.**
6. Awns articulate with the valve just below the branching point, but not deciduous 7
Awns perfectly continuous with the valve 8
7. Sheaths naked at the mouth ... ... **A. congesta.**
Sheaths bearded at the mouth ... ... **A. barbicollis.**
8. Annual. Valve not beaked. Anthers ½ lin. long ... **A. adscensionis.**
Perennial. Valve narrowed into a beak. Anthers 1-3 lin. long 9
9. Panicle open, lax; branches 3-6 in. long 10
Panicle narrow, contracted, often spike-like 11
10. Blades 8-12 in. long. Spikelets 5-6 lin. long. Awns up to 1 in. long ... ... **A. burkei.**
Blades 1-4 in. long. Spikelets 3-4 lin. long. Awns 4 lin. long ... ... **A. bipartita.**
11. Culms woolly below the nodes. Panicle 1-1½ feet long. **A. sciurus.**
Culms glabrous. Panicle 2-6 in. long 12
12. Glumes sub-equal, shortly mucronate ... **A. aequiglumis.**
Glumes unequal 13
13. Culms terete. Spikelets 5-6 lin. long. Valves exserted. **A. angustata.**
Culms compressed below. Spikelets 3½-4½ lin. long. Valves not exserted. Glumes aristulate ... **A. junciformis.**
14. Awn continuous with the valve. Whole plant hairy. **A. sericans.**
Awn disarticulating 15
15. Valve gradually passing into the awn 16
Valve minutely and obtusely 2 lobed. Awn from the sinus 20
16. Glumes emarginate. Sheaths long bearded at the mouth. **A. ciliata.**
Glumes acuminate. Tips minutely truncate, convolute 17

17. Side bristles of the awn sparingly ciliate ... **A. lutescens.**
All the bristles of the awn plumose 18

18. Awn tardily disarticulating with the tip of the valve. **A. capensis.**
Awn readily deciduous with the upper half of the valve 19

19. Suffrutescent. Spikelets 6-7 lin. long. Middle bristle 9-12 lin. long ... ... **A. namaquensis.**
Not suffrutescent. Spikelets up to 4 lin. long. Middle bristle 3-4 lin. long ... ... **A. proxima.**

20. Lower glume rather longer than the upper 21
Lower glume shorter than the upper 22

21. Annual, about 1 in. high. Panicles ½ in. long ... **A. subacaulis.**
Perennial, 3-12 in. high. Panicles 1-6 in. long. **A. obtusa.**

22. Panicle narrow, rather lax, not spike-like 23
Panicle spike-like 24

23. Culms 1½-2 ft. 4 noded. Awn plumose from below branching point ... ... **A. uniplumis.**
Culms ½ ft. 1 noded. Middle awn plumose in the upper half ... ... **A. dregeana.**

24. Culms up to ½ ft. Panicle hairy ... ... **A. geminifolia.**
Suffrutescent. Panicle glabrous ... ... **A. brevifolia.**

ATROPIS.

Leaves 1-1½ lin. broad when expanded. Panicles ovate to subdeltoid with rather coarse and stiff spreading branches ... ... **A. borreri.**
Leaves up to ¾ lin. broad. Panicle linear, with erect finely filiform to capillary branches ... **A. angusta.**

AVENA.

1. Valves glabrous or hairy at the base only. Rachilla tough or tardily disarticulating ... ... **A. sativa.**
Valves hairy to or beyond the middle. Rachilla readily disarticulating 2

2. Spikelets 15-20 lin. long. Rachilla glabrous between the valves ... ... **A. sterilis.**
Spikelets 9-14 lin. long. Rachilla villous between the valves 3

3. Valves shortly bifid ... ... **A. fatua.**
Valve lobes produced into long bristles ... **A. barbata.**

AVENASTRUM.

1. Spikelets 6-9 lin. long. Rachilla joints 1½-2 lin. long, hairy 2
   Spikelets 3½-6 lin. long. Rachilla joints ½-1 lin. long 4
2. Spikelets 2-3 flowered, as long as, or slightly longer than the glumes ... ... **A. quinquesetum.**
   Spikelets 3-4 flowered, much longer than the glumes 3
3. Panicle 6-9 in. long. Leaves long, flaccid ... **A. longum.**
   Panicle 2-3 in. long. Leaves mostly basal, short, sub-rigid ... ... **A. dregeanum.**
4. Spikelets rather compact, slightly turgid. Valves imbricate ... ... **A. turgidulum.**
   Spikelets looser. Valves not imbricate, spreading, narrow 5
5. Panicle flexuous. Rachilla long, hairy. Valves thin, smooth ... ... **A. caffrum.**
   Panicle narrow, branches adpressed. Valves sub-cartilaginous, below the awn, scaberulous or granulate 6
6. Blades 9-20 in. by 2-2½ lin. Spikelets 5-6 lin. long. Rachilla long hairy ... ... **A. dodii.**
   Blades 2-9 in., very narrow. Spikelets 3½-5½ lin. Rachilla glabrous or shortly hairy ... ... **A. antarticum.**

BRACHYPODIUM.

1. Annual. Anthers ¼-⅓ lin. long ... ... **B. distachyum.**
   Perennial. Anthers 1½-2 lin. long 2
2. Culms leafy for more than half their length ... **B. flexum.**
   Leaves crowded at the base ... ... **B. bolusii.**

BRIZA.

Spikelets 5-8 lin. long ... ... **B. maxima.**
Spikelets 1-2 lin. long ... ... **B. minor.**

BRIZOPYRUM.

1. Spikelets in 2 ranked spikes or the lower clustered 2
   Spikelets in spike-like panicles all round the axis ... 4
2. Glumes and valves subcoriaceous, very obscurely nerved. Leaves rigid ... ... **B. capense.**
   Glumes and valves thinner. Nerves prominent in upper part. Leaves glaucous, not rigid 3
3. Spikelets loosely imbricate, 3½-4 lin. long. Leaves long, flaccid ... ... **B. alternans.**
   Spikelets tightly imbricate, 2-2½ lin. long. Leaves short. **B. brachystachyum.**

4. Spikelets 2-2½ lin. long. Valves with clavate tipped cilia. **B. acutiflorum.**
   Spikelets 1¼-2 lin. long. Valves with acute cilia or bristles 5
5. Spikelets finely hirsute all over. Glumes with bristles. **B. ciliare.**
   Leaves glabrous (except at the mouth). Glumes glabrous 6
6. Uppermost sheath usually exceeding base of panicle. **B. obliterum.**
   Uppermost sheath remote from the panicle ... ... **B. glomeratum.**

BROMUS.

1. Glumes and valves strongly compressed, acutely keeled. Valve about 13-nerved ... ... **B. unioloides.**
   Glumes and valves not both strongly compressed and keeled. Valves fewer than 13 nerved 2
2. Valves 1 in. long. Lower glume 7-10 lin. Upper glume 11-14 lin. Awn 2-2½ in. ... ... **B. maximus.**
   Valves less than ¾ in. long. Lower glume less than 7 lin. long. Upper glume less than 8 lin. long. Awn much shorter 3
3. Perennial, often tall. Lower glume 1-3 nerved, upper 3-5 nerved 4
   Annual. Lower glume 3-5, rarely 1-nerved, upper 5-9 nerved 7
4. Lower glume 1 (rarely 3), upper 3-nerved. Anthers 1-1½ lin. long ... ... **B. leptoclados.**
   Lower glume 3, upper usually 5-nerved. Anthers about 3 lin. long 5
5. Spikelets glabrous. Valves prominently nerved ... **B. natalensis.**
   Spikelets hairy. Valve nerves not prominent 6
6. Florets rather loose. Valves linear-lanceolate, narrow. **B. speciosus.**
   Florets close. Valves lanceolate-cuneate, rather broad above ... ... **B. firmior.**
7. Panicle contracted, dense. Branches shorter than the spikelets ... ... **B. molliformis.**
   Panicle loose. Lower branches much longer than the spikelets, flexuous 8
8. Panicle becoming effuse. Branches 3-5 in. long ... **B. arvensis.**
   Panicle more or less secund. Branches less than 2 in. long 9

9. Florets close. Valve tips obtuse. Awns of lower valves usually much shorter than those of the upper ... **B. commutatus.**
   Florets rather loose. Valve tips acute, entire or 2-toothed. Awns nearly equal ... ... **B. patulus.**

CHAETOBROMUS.

1. Blades usually silky below. Lowest valve contracted into a bristle, 2½ lin. long ... ... **C. involucratus.**
   Blades glabrous below. All the valves with a kneed awn, 6-7 lin. long 2
2. Culms erect, blades 2-5 in. long. Lowest valve without side bristles ... ... **C. dregeanus.**
   Culms ascending. Blades 6-10 in. long. All the valves with side bristles ... ... **C. schraderi.**

CHLORIS.

1. Upper glume very broad, shortly bilobed, mucronate. Valves mucronate ... ... **C. petraea.**
   Glumes narrow, acute or mucronate, keeled. Valves awned 2
2. Awns as long as the valve or a little longer ... **C. gayana.**
   Awns 3-6 times the length of the valve 3
3. Rudimentary floret minute, on a long rachilla joint. **C. pycnothrix.**
   Rudimentary floret more than ½ the length of the fertile floret, on a rather short rachilla joint ... **C. virgata.**

CYNODON.

Culms many noded, with leaves mostly crowded at the base. Ligule a ciliate rim. Rachilla produced ... **C. dactylon.**
Culms 2-3 noded. Ligule membranous. Rachilla not produced ... ... **C. incompletus.**

DANTHONIA.

1. Spikelets 1½-2 inches long 2
   Spikelets 1 inch or less 3
2. Blades 6-12 inches long, filiform, tapering to a long setaceous point ... ... **D. macrantha.**
   Blades 2-3 inches long, linear; tips filiform, obtuse. **D. brachyphylla.**

3. Lower sheaths more or less covered with a coat of wool. Panicles usually capitate 4
Lower sheaths glabrous, or minutely pubescent or tomentose. Panicles not capitate 7

4. Panicle loosely contracted ... ... **D. zeyheriana.**
Panicle compact spike-like or capitate 5

5. Spikelets 10-12 lin. long in large heads 2-2½ in. long. **D. macrocephala.**
Spikelets smaller, 4-8½ lin. long 6

6. Spikelets 6-8½ lin. long. Glumes narrow, long and acutely acuminate ... ... **D. lanata.**
Spikelets 4-7 lin. long. Glumes rather broad, shortly acuminate or mucronate ... ... **D. lupulina.**

7. Spikelets awnless, or awn reduced to a mucro 8
Spikelets distinctly awned 9

8. Spikelets 2 lin. long. Awn reduced to a mucro from a sinus ... ... **D. inermis.**
Spikelets turgid, 4-6 lin. long, awnless ... **D. decumbens.**

9. Dwarf plants. Blades not exceeding 2 inches. Culms 1-2 noded 10
Not dwarf 13

10. Valve lobes obtuse, hyaline 11
Valve lobes mucronate, or long setaceously acuminate 12

11. Perennial. Valve lobes ciliate ... ... **D. purpurea.**
Annual. Valve lobes truncate, not ciliate ... **D. tenella.**

12. Spikelets 5-6 lin. long. Valve lobes mucronate ... **D. pumila.**
Spikelets 2-2½ lin. long. Valve lobes long, setaceously acuminate ... ... **D. curva.**

13. Spikelets 2-4½ lin. long 14
Spikelets about 6 lin. (rarely to 10 lin.) long. Rather coarse grasses 16

14. Spikelets 2-2½ lin. long. Valve lobes long, setaceously acuminate ... ... **D. curva.**
Spikelets 3½-4½ lin. long. Valve lobes not setaceously acuminate 15

15. Suffrutescent. Lower sheaths coriaceous ... ... **D. suffrutescens.**
Herbaceous. Lower sheaths thin ... ... **D. glauca.**

16. Inflorescence a distichous linear spike ... ... **D. disticha.**
Inflorescence a true contracted panicle 17

17. Valves loosely villous, hairs not in tufts. Lower sheaths pubescent or tomentose and pruinose, but not covered with a coat of wool ... ... **D. elephantina.**
Valves with distinct tufts of hairs. Sheaths glabrous except sometimes near the mouth or at the very base 18

18. Sheaths woolly at the mouths. Hair tufts of valve 3 on each side at the base of the lobes, and equal to them. **D. papposa.**
Sheaths glabrous or almost so. Valve tufts of hairs forming a dense straight transverse fringe at or near its middle, or in an oblique transverse fringe near the base, or submarginal on each side 19

19. Culms and leaves very robust. Tufts of hairs a transverse fringe at or near the middle of the body of the valve ... ... **D. cincta.**
Culms and leaves more slender, firm. Fringe of hairs sub-marginal or basal 20

20. Glumes 1 or lower sub- 3 nerved. Tufts of hair in an oblique fringe near the base of valve. Lobes of valve almost wholly adnate to the awn ... ... **D. macowani.**
Glumes 5-3 nerved. Valve tufts of hairs submarginal; lobes free from the awn 21

21. Blades wiry. Lobes of the valve mucronate ... **D. dura.**
Blades filiform. Lobes of the value acute, with a slender side bristle ... ... **D. stricta.**

DIGITARIA.

1. Racemes rather lax, compound near the base, villous with long silky, often purplish, hairs, conniving into a brush-like point 2
Racemes simple or nearly so. Spikelets glabrous or covered with fine adpressed hairs 3

2. Racemes sessile or subsessile, sub-digitate ... ... **D. tricholaenoides.**
Racemes peduncled, in a scantily branched panicle. **D. flaccida.**

3. Racemes setose. Spikelets surrounded by stiff hairs from tips of the pedicels ... ... **D. diagonalis.**
Racemes not setose 4

4. Racemes solitary, dense, densely villous ... ... **D. monodactylon.**
Racemes 2 to many 5

5. Spikelets quite glabrous ... ... **D. diversinervis.**
   Spikelets not quite glabrous 6
6. Racemes contiguous, often resembling a solitary raceme. **D. argyrograpta.**
   Racemes never contiguous except in a very young state 7
7. Perennial 8
   Annual 9
8. Culms rather stout 1½-3 ft. Blades ½-1 ft. by 1-2 lin. **D. eriantha.**
   Culms slender ½-1 ft. Blades setaceous, 2-6 in. long. **D. setifolia.**
9. Pedicels terete, smooth ... ... **D. tenuiflora.**
   Pedicels angular, scabrid 10
10. Pedicels shortly hairy near the tips. Spikelets obtuse, silky with clavate tipped hairs in very slender long racemes ... ... **D. ternata.**
    Pedicels glabrous. Hairs of spikelets not clavate ... 11
11. Upper glume long acuminate, exceeding the upper valve. **D. debilis.**
    Upper glume shorter than the upper valve 12
12. Spikelets ¾-1 lin. long. Lower glume 0. Valves closely nerved ... ... **D. horizontalis.**
    Spikelets 1-1¼ lin. long. Lower glumes usually distinct. Inner lateral nerves of the lower valve rather distant from the middle nerve ... ... **D. sanguinalis.**

DIPLACHNE.

1. Blades ½-2 in. long, very rigid, pungent ... **D. paucinervis.**
   Blades 3-9 in. long, flaccid or sub-rigid, never pungent 2
2. Spikelets 2-3 flowered, reddish. Valves shortly awned. **D. biflora.**
   Spikelets 5-10 flowered, light green. Valves awnless or mucronulate 3
3. Blades more or less flaccid. Ligules very short. Valves obtuse ... ... **D. eleusine.**
   Blades more or less rigid. Ligules up to 2½ lin. long. Valves minutely emarginate ... ... **D. fusca.**

EHRHARTA.

1. Empty valves subulate -caudate, similar in outline, equal or unequal, 2-4 times the length of the glumes ... 2
   Empty valves not subulate-caudate, less than twice the length of the glumes, or if subulate-caudate then the culm is bulbous at the base, or the empty valves are very dissimilar 5

2. Flaccid annuals. Lower empty valve exceeding the fertile 3
Perennials with crowded basal leaves. Lower empty valve shorter than the fertile 4

3. Fertile valve 1-1¼ lin. long, equalling or slightly exceeding the glumes ... ... **E. triandra.**
Fertile valve 2½-2¾ lin. long, much exceeding the glumes. Stamens 6 ... ... **E. longiflora.**

4. Leaves 2-5 lin. broad, when flat ... ... **E. dura.**
Leaves filiform ... ... **E. microlaena.**

5. Culms bulbous at the base, simple, 2-3 noded. Empty valves sub-equal 6
Culms not bulbous or if sub-bulbous then branched, 4-6 noded, or empty valves unequal 8

6. Lower empty valve almost equally wide throughout. Blades usually convolute, rigid ... ... **E. longifolia.**
Lower empty valve widening above the middle, or like the upper coarsely rugose. Blades usually flat, broad 7

7. Spikelets 3 lin. long ... ... **E. bulbosa.**
Spikelets 4-6 lin. long ... ... **E. capensis.**

8. Lower empty valve less than ⅓ length of the upper, differing from it in substance 9
Empty valves similar, or lower, shorter and narrower but like upper in substance 13

9. Culm coarse, almost woody, below. Blades very rigid 10
Culms and blades fine to very fine 11

10. Glumes about ⅓ the length of the spikelet ... ... **E. rupestris.**
Glumes ¾-⅝ the length of the spikelet ... ... **E. setacea.**

11. Glumes equalling the spikelet ... ... **E. uniflora.**
Glumes scarcely ⅓ the length of the spikelet 12

12. Spikelets in 2-9 spiculate racemes ... ... **E. tricostata.**
Spikelets solitary ... ... **E. dodii.**

13. Spikelets 4½-7½ lin. long. Upper empty valve not hinged by an appendage to the fertile 14
Spikelets 1-2½ lin. long or if up to 4 lin. long, then upper empty valve hinged to the fertile, by an ear shaped appendage on a pivot like knob 16

14. Lower nodes reversedly hairy. Keels of empty valves long hairy ... ... **E. barbinodis.**
Nodes glabrous. Empty valves hairy all over 15

15. Innovation buds or young stolons covered with villous scales. Culms erect ... ... **E. gigantea.**
Innovation buds with only basal scales fugaciously tomentose. Culms ascending from a decumbent and rooting base ... ... **E. villosa.**
16. Spikelets 1-1¾ lin. long or if up to 2½ lin. (E. erecta), then the upper empty valve with a pair of obscure beardless ridges, and no definite appendages at the base 17
Spikelets 2-4 lin. long. Upper empty and fertile valves hinged together 20
17. Empty valves very similar and sub-equal, exserted from the glumes 18
Upper empty valve about equalling the glumes. Lower ½ length of the upper 19
18. Perennial. Spikelets 1½-2½ lin. long. Stamens 6. **E. erecta.**
Annual. Spikelets 1 lin. long. Stamens 3. **E. delicatula.**
19. Perennial with basal tufts of villous leaves. Valves glabrous ... ... **E. melicoides.**
Annual. Empty valves hairy ... ... **E. brevifolia.**
20. Suffrutescent. Blades very much reduced or suppressed 21
Not suffrutescent. Blades flat or convolute 22
21. Culms stout, usually bladeless. Glumes usually shorter than the valves ... ... **E. ramosa.**
Culms slender, sometimes bearing short blades. Glumes slightly exceeding the valves ... ... **E. aphylla.**
22. Empty valves glabrous 23
Empty valves hairy 24
23. Spikelets erect, 3-4 lin. long. Panicle spike-like ... **E. subspicata.**
Spikelets nodding on the flexuous rachis of a raceme, 2½-3 lin. long ... ... **E. rehmanni.**
24. Annual. Culms ½-1 ft., 2-3 noded ... ... **E. pusilla.**
Perennial. Culms 1-2 ft., 4-6 noded ... ... **E. calycina.**

ELEUSINE.

Spikes slender. Valves acute ... ... **E. indica.**
Spikes thick, often curved. Valves obtuse ... **E. coracana.**

ENNEAPOGON.

1. Awns scaberulous along the margins ... ... **E. scaber.**
Awns distinctly plumose or ciliate 2

2. Almost glabrous. Culms very wiry, 1-2 ft. long ... **E. scoparius.**
   All parts softly glandular-pubescent. Nodes villous. Culms not wiry 3
3. Culms 2-6 inches long. Side nerves of glume evanescent above ... ... **E. brachystachyus.**
   Culms 1-3 ft. long. Two side nerves of the upper glume percurrent ... ... **E. mollis.**

ERAGROSTIS.

1. Valves or pales long ciliate 2
   Valves and pales not long ciliate 3
2. Perennial. Both valves and pales ciliate ... ... **E. lappula.**
   Annual. Pales ciliate. Valves not ciliate except sometimes at the base of the keel ... ... **E. ciliaris.**
3. Spikelets small, breaking up into false fruits consisting of the grain enclosed by its valve and pale 4
   Spikelets variously breaking up but not into false fruits 6
4. Panicle large, very lax. Spikelets linear, on long fine pedicels. All parts scabrid ... ... **E. aspera.**
   Panicle linear to oblong, usually contracted. Spikelets very shortly pedicelled 5
5. Perennial. Valves ¾ lin. long. Culms usually viscous at the nodes ... ... **E. gummiflua.**
   Annual. Valves 2-5 lin. long. Culms not viscous ... **E. namaquensis.**
6. Spikelets orbicular to ovate—oblong in outline, obtuse, not more than twice as long as broad. Rachilla usually disarticulating 7
   Spikelets linear to oblong, often several times longer than broad. Rachilla usually persistent 13
7. Spikelets very flat, straw coloured, articulate with pedicels, deciduous ... ... **E. superba.**
   Spikelets not deciduous with the pedicels, breaking up, smaller 8
8. Spikelets ovate or suborbicular, strongly compressed, 2-6 lin. by 1½-3½ lin. ... ... **E. brizoides.**
   Spikelets smaller. Valves not more than 1 lin. long... 9
9. Culms branched ... ... **E. echinochloidea.**
   Culms simple 10
10. Small annual. Valve about ⅓ lin. long ... **E. brizantha.**
    Perennial. Valve about 1 lin. long 11
11. Spikelets on capillary branches and pedicels ... **E. obtusa.**
    Spikelets crowded on very short pedicels or subsessile 12

12. Valves broadly truncate, their broad upper halves closely imbricate; sides rather flat ... ... **E. truncata.**
Valves rounded-obtuse, loosely imbricate; sides rather convex ... ... **E. bergiana.**

13. Panicle more or less rigid (except sometimes in **E. gangetica**). Valves rigidly membranous to sub-chartaceous 14
Panicle usually delicate with fine divisions, flexuous or nodding, rarely rigid. Valves thinly membranous except in **E. dura**) 28

14. Annual 15
Perennial 18

15. Leaves usually covered with minute gland-tipped hairs. Pedicels with a ring at the middle. Grain excavated in front ... ... **E. annulata.**
Leaves, pedicels and grain not all as described for **E. annulata** 16

16. Nodes glabrous 3-4. Valves 1-1¼ lin. long 17
Nodes bearded 5-6. Valves ¾ lin. long ... **E. barbinodis.**

17. Leaf blades usually glandular along the margins. Valves obtuse or sub-obtuse ... ... **E. major.**
Leaves eglandular. Valves acute or mucronulate ... **E. procumbens.**

18. Blades more or less subulate, pungent. Culms leafless and nodeless above the base 19
Blades neither subulate nor pungent. Culms 1 or more noded and more or less leafy above the base 20

19. Spikelets in dense, distant clusters along the stout axis of a panicle ... ... **E. cyperoides.**
Spikelets loosely racemose, on the spiny branches of a panicle ... ... **E. spinosa.**

20. Panicle very broad and lax. Spikelets scattered over the periphery ... ... **E. patentissima.**
Panicle, contracted, narrow. Spikelets much closer 21

21. Rachilla breaking up. Valves rather loosely imbricate, very acute ... ... **E. denudata.**
Rachilla persistent or sub-persistent. Valves closely imbricate, less acute 22

22. Spikelets reddish-brown. Stamens 2 ... ... **E. chapelieri.**
Spikelets not reddish-brown. Stamens 3 23

23. Basal sheaths tomentose, woolly below ... **E. sclerantha.**
Basal sheaths glabrous or with scattered hairs 24

24. Valves ovate to ovate-oblong, 1 lin. long; side nerves rather inconspicuous. Anthers $\frac{1}{2}$-$\frac{2}{3}$ lin. long ... 25
Valves oblong. $\frac{3}{4}$-1 lin. long; side nerves prominent. Anthers $\frac{1}{4}$-$\frac{3}{8}$ lin. long 26
25. Spikelets ovate-oblong, $2\frac{1}{4}$-4 lin. long, olive green to leaden grey ... ... **E. chalcantha.**
Spikelets linear, 4-5 lin. long, yellowish-green. **E. pallens.**
26. Panicle often nodding, contracted. Spikelets up to 8 lin. long ... ... **E. gangetica.**
Panicle erect, very slender, with short branches adpressed to the axis. Spikelets $2\frac{1}{2}$-4 lin. long 27
27. Not stoloniferous. Culms 2-3 noded. Spikelets 1-$1\frac{1}{4}$ lin. wide ... ... **E. elatior.**
Stoloniferous. Culms many noded with decumbent base. Spikelets $\frac{2}{3}$-$\frac{4}{5}$ lin. wide ... ... **E. sarmentosa.**
28. Annual. Spikelets 1 lin. long, 2-4, rarely 3 flowered, on long fine pedicels ... ... **E. biflora.**
Perennial or if annual then spikelets 3-11 flowered and very shortly pedicelled 29
29. Creeping in sand ... ... **E. glabrata.**
Not creeping in sand 30
30. Glumes very unequal; lower rarely over $\frac{1}{3}$ lin. long, sometimes suppressed 31
Glumes sub-equal, or if unequal, then lower $\frac{1}{2}$ lin. long or more, and upper not more than $1\frac{1}{2}$ times as long 32
31. Lower sheaths strongly compressed. Spikelets 3-6 lin. by 1 lin. ... ... **E. plana.**
Lower sheaths not strongly compressed. Spikelets 2-4 lin. by $\frac{1}{2}$-$\frac{3}{4}$ lin. ... ... **E. heteromera.**
32. Valves $1\frac{1}{2}$-$1\frac{3}{4}$ lin. long ... ... **E. caesia.**
Valves about 1 lin. long or shorter, rarely slightly longer 33
33. Spikelets 4-13 flowered (rarely 3), 2-7 lin. long, rarely shorter 34
Spikelets 2-4 flowered, $\frac{3}{4}$-2 lin. long 42
34. Valves 1 lin. long or slightly longer ... ... **E. curvula.**
Valves $\frac{2}{3}$ to 1 lin. long 35
35. Spikelets 3-6 flowered, pallid 36
Spikelets 4-13 flowered, more or less dark grey or purple 37
36. Spikelets about 1 lin. broad. Panicle pyramidal, axils naked ... ... **E. poa.**
Spikelets $\frac{2}{3}$-$\frac{3}{4}$ lin. broad. Panicle oblong, with bearded axils ... ... **E. wilmsii.**

37. Valves purple or violet with yellowish tips ... **E. bicolor.**
Valves not purple or violet with yellowish tips 38
38. Annual. Valves very obtuse, truncate or submarginate. **E. porosa.**
Perennial. Valves acute or obtuse, not truncate ... 39
39. Culms repeatedly geniculate, branched. Valves imbricate, obtuse ... ... **E. lehmanniana.**
Culms simple or if sparingly branched below then valves looser and more acute 40
40. Sheaths bearded; lower not or indistinctly compressed. **E. chloromelas.**
Sheaths beardless or almost so; lower compressed and keeled 41
41. Pedicels up to 1 lin. long. Blades about 6 inches. **E. margaritacea.**
Pedicels and branches very long, capillary flexuous. Blades 1 ft. long or longer ... ... **E. nebulosa.**
42. Glumes and valves firm, almost chartaceous, shining. Spikelets oblong ... ... **E. dura.**
Glumes and valves thin to very thin. Spikelets lanceolate 43
43. Culms branched, 5-6 noded. Branches solitary, or lowermost sub-opposite ... ... **E. burchellii.**
Culms simple or almost so, 2-5 noded. Branches of panicle more or less whorled 44
44. Panicle somewhat dense and rigid. Pedicels very short. Valves acute ... ... **E. sporoboloides.**
Panicle very lax; divisions capillary, flexuous. Pedicels 1 lin. long or much longer. Valves obtuse or subobtuse 35
45. Panicle long, exserted from the uppermost sheath ... **E. atherstonei.**
Panicle shortly exserted from, or enclosed at the base in the uppermost sheath ... ... **E. micrantha.**

ERIANTHUS.

1. Blades subterete, solid ... ... **E. junceus.**
Blades not terete 2
2. Blades flat, 4-6 lin. wide. Rachis and branches of panicle glabrous ... ... **E. capensis.**
Blades almost reduced to midrib below, 2 lin. wide. Rachis and branches of panicle pubescent at the nodes ... ... **E. sorghum.**

FESTUCA.

1. Blades permanently folded, filiform or setaceous ... **F. caprina.**
   Blades flat or involute when dry 2
2. Top of ovary glabrous. Ligules extremely short ... **F. vulpioides.**
   Top of ovary hairy. Ligules 1-2 lin. long 3
3. Dioecious. Panicles dense and almost spike-like, sometimes interrupted ... ... **F. scabra.**
   Hermaphrodite. Panicle compound or subcorymbose 4
4. Panicle compound more or less nodding. Spikelets 6-8 lin. long. Valves finely nerved ... ... **F. costata.**
   Panicle subcorymbose, at length divaricate. Spikelets 4-5 lin. long. Valves 5 ribbed ... ... **F. longipes.**

FINGERHUTHIA.

Glumes long and finely ciliate. Finely awned ... ... **F. africana.**
Glumes rigidly ciliolate. Mucronate ... **F. sesleriaeformis.**

HOLCUS.

Annual. Spikelets 1½ lin. long. Upper glume awned. **H. setiger.**
Perennial. Spikelets 2 lin. long. Upper glume awnless. **H. lanatus.**

HORDEUM.

Perennial. All the glumes alike, subulate-aristate ... **H. secalinum.**
Annual. Glumes of the intermediate spikelets narrow, ciliate ... ... **H. murinum.**

ISCHAEMUM.

1. Blades setaceously filiform. Lower glume rough, tuberculate ... ... **I. franksae.**
   Blades 2-6 lin. broad. Lower glume not tuberculate 2
2. Blades 3-6 lin. broad. Lower glume 5 ribbed ... ... **I. fasciculatum.**
   Blades 2 lin. broad. Lower glume not ribbed ... ... **I. glaucostachyum.**

LASIOCHLOA.

1. Annual. Glumes caudate-acuminate. Mucros ¾-1½ lin. long ... ... **L. ciliaris.**
   Perennial. Glumes acute or acutely acuminate, not mucronate 2

2. Glumes acuminate, coarsely hispid. Blades acute 6-12 inches long ... ... **L. longifolia.**
Glumes acute, finely hispid. Blades with an obtuse callous point 3-4 in. long ... ... **L. obtusifolia.**

LOLIUM.

1. Florets turgid, the uppermost equalled or exceeded by the glume ... ... **L. temulentum.**
Florets not turgid 2
2. Rather tall; axis slender. Glume much shorter than the spikelet ... ... **L. multiflorum.**
Short; axis stout. Glume equalling the spikelet ... **L. rigidum** var. **rottboellioides.**

MELICA.

1. Valve hairy all over 2
Valve hairy only along the sides 3
2. Culms profusely branched. Spikelets up to 4 lin. long. **M. necsii.**
Culms simple. Spikelets 5½-7 lin. long ... **M. decumbens.**
3. Leaves hairy. Fertile floret 1, shorter than upper glume. **M. bolusii.**
Leaves glabrous. Fertile florets 2, not shorter than upper glume 4
4. Culms 3-6 inches, profusely branched ... ... **M. pumila.**
Culms 2-3 feet, simple or scantily branched 5
5. Spikelets 3-5 lin. long. Upper glume rather narrow. **M. racemosa.**
Spikelets 2-3 lin. long. Glumes broad ... ... **M. ovalis.**

MICROCHLOA.

Spikelets 1-1½ lin. long. Valve abruptly and shortly acuminate ... ... **M. setacea.**
Spikelets 1¾-2¼ lin. long. Valve minutely cuspidate ... **M. caffra.**

PANICUM.

1. Spikelets in racemosely arranged secund, or sub-secund false spikes 2
Spikelets in loose or rarely in dense cylindrical panicles 16
2. Spikelets 1-2 ranked, or if 4 ranked then glumes and valves not cuspidate, nor awned 3
Spikelets 4 or more ranked, or if 2 ranked then glumes cuspidate or awned 12

3. Spikelets usually 1 ranked, $2\frac{1}{2}$ lin. long, turgid, very obtuse, glabrous ... ... **P. brizanthum.**
   Spikelets 2 (rarely 4) ranked, less than $2\frac{1}{2}$ lin. long 4
4. Spikelets turgid, silky villous. Upper hairs in tufts 5
   Spikelets not turgid, nor silky villous. Upper hairs not in tufts except in **P. marlothii** which is 4 ranked 7
5. Spikelets not constricted at the base, $1\frac{1}{4}$-$1\frac{1}{2}$ lin. long. **P. serratum.**
   Spikelets constricted at the base, 2-3 lin. long 6
6. Spikelets 2 lin. long ... ... **P. nigropedatum.**
   Spikelets 3 lin. long ... ... **P. mesocomum.**
7. Spikelets 1 lin. long, finely pubescent 8
   Spikelets more than 1 lin. long, not finely pubescent 9
8. Spikelets 2 ranked; no tufts of hairs ... ... **P. isachne.**
   Spikelets 4 ranked with minute terminal tufts of hairs. **P. marlothii.**
9. Fruiting valve smooth. Spikelets loosely white hairy. **P. glomeratum.**
   Fruiting valve wrinkled. Spikelets glabrous, or valve ciliate along margins 10
10. Lower glume with 1-3 bristles from the centre. Lower valve rigidly ciliate along one or both margins ... **P. trichopus.**
    Spikelets glabrous 11
11. Fruiting valve mucronate. Lower glume turned away from the rachis ... ... **P. helopus.**
    Fruiting valve not mucronate. Lower glume facing the rachis ... ... **P. arrectum.**
12. Ligule O 13
    Ligule a fringe of hairs 14
13. Culms stout terete. False spikes compound in dense panicles ... ... **P. crus-pavonis.**
    Culms and sheaths compound below. False spikes simple or sub-simple ... ... **P. crus-galli.**
14. False spikes erect. Glumes and lower valve woolly ciliate ... ... **P. holubii.**
    False spikes oblique or spreading. Glumes and valve not woolly ciliate 15
15. False spikes solitary, usually awned ... ... **P. stagninum.**
    False spikes fascicled or crowded, shortly cuspidate. **P. pyramidale.**
16. Panicle cylindrical or if sometimes open (P. curvatum) then the spikelets strongly curved 17
    Panicle loose or effuse 19

17. Axis very slender. Spikelets strongly curved ... ...
P. curvatum.
Axis stout. Panicle always cylindrical 18
18. Spikelets olive green, with dark tips. Blades flaccid.
P. interruptum.
Spikelets purplish, slightly curved. Blades rigid ...
P. typhurum.
19. Culms either (1) slender to very slender, ascending; or (2) compactly caespitose 20
Culms robust often very tall. Blades $\frac{1}{3}$-2 ft. by 2-8 lin. 32
20. Culms very slender ascending from a trailing or rambling base many noded, often branched. Leaves $\frac{1}{2}$-3 inches 21
Culms slender, compactly caespitose, or if decumbent at the base then rather stout. Leaves usually 3-5 inches 27
21. Lower valve 7-9 nerved 22
Lower valve 5 nerved 25
22. Lower branches of panicle 3-6 in. long. Pedicels $\frac{1}{2}$-$1\frac{1}{4}$ ins. long ... ... **P. perlaxum.**
Lower branches of panicle $\frac{1}{2}$-$2\frac{1}{2}$ ins. long. Pedicels $\frac{1}{2}$-1 lin. long 23
23. Spikelets acute to acuminate, often pubescent ...
P. aequinerve.
Spikelets obtuse, glabrous 24
24. Leaves glabrous. Lower glume not more than $\frac{1}{3}$ length of spikelet ... ... **P. filiculme.**
Leaves finely hairy. Lower glume $\frac{1}{2}$ length of spikelet.
P. hymeniochilum.
25. Panicle large effuse. Spikelets 1 lin. long. **P. laticomum.**
Panicle scanty. Spikelets $1\frac{1}{2}$-2 lin. long 26
26. Blades shortly petioled. Longer pedicels up to $1\frac{1}{2}$ lin. long ... ... **P. chusqueoides.**
Blades not petioled. Longer pedicels up to 4 lin. long.
P. obumbratum.
27. Glumes and lower valve 3-5 toothed ... ... **P. ecklonii.**
Glumes and lower valve entire 28
28. Culms 4-many noded, from a creeping rhizome or decumbent, branched base 29
Culms 1-3 (rarely 4) noded, simple; densely caespitose 30
29. Stoloniferous. Lower leaves distichously imbricate, $1\frac{1}{2}$-3 lin. broad, usually rigid and involute ... ... **P. repens.**
Not stoloniferous. Leaves more distinct, broader, flat, rather flaccid ... ... **P. coloratum.**

30. Glumes and lower valve equal, very similar, 5 nerved. **P. natalense.**
Lower glume smaller. Upper glume 7 nerved 31
31. Lower valve 9 nerved ... ... **P. minus.**
Lower valve 5 nerved ... ... **P. dregeanum.**
32. Spikelets obtuse or sub-obtuse 33
Spikelets distinctly acute or acuminate 36
33. Spikelets 2-3 lin. long, turgid 34
Spikelets 1-1½ lin. long, not turgid 35
34. Tips of glumes and lower valve callous. Lower valve 5 nerved ... ... **P. zizanioides.**
Tips of glumes and lower valve not callous. Lower valve 7 nerved ... ... **P. deustum.**
35. Perennial. Lower valve 5 nerved. Upper finely wrinkled. **P. maximum.**
Annual. Lower valve 7-9 nerved. Upper quite smooth. **P. laevifolium.**
36. Pedicels very short. Spikelets glaucous. Glume and valve faintly 5 nerved ... ... **P. meyerianum.**
Pedicels 2-6 lin. long. Spikelets not glaucous. Glume and valve distinctly 5-13 nerved 37
37. Spikelets acute. Upper glume 11-13 nerved ... **P. miliare.**
Spikelets acuminate. Upper glume 5-9 nerved 38
38. Longer pedicels up to 2½ lin. long ... ... **P. proliferum.**
Longer pedicels up to 6 lin. long ... ... **P. capillare.**

PASPALUM.

1. Culms usually erect. Spikelets obtuse or sub-obtuse. **P. scrobiculatum.**
Culms ascending from a creeping base. Spikelets acute 2
2. Lateral false spikes sessile or subsessile ... **P. digitaria.**
False spike peduncled ... ... **P. distichum.**

PENNISETUM.

1. Involucre reduced to a solitary bristle ... **P. unisetum.**
Involucre not reduced to 1 bristle 2
2. Annual. Tall stout plant. Involucre peduncled ... **P. typhoideum.**
Perennial, not stout. Involucres sessile 3
3. Bristles plumose ... ... **P. cenchroides.**
Bristles not plumose 4
4. Anther tips penicellate. Styles connate or cohering for half their length. Lodicules 0 ... ... **P. thunbergii.**
Anther tips naked. Styles almost free. Lodicules distinct 5

5. Culms pubescent or hirsute below the panicle. Blades very narrow. Panicle 2-4 in. long ... **P. sphacelatum.**
Culms glabrous, smooth or scaberulous below the panicle. Blades 2-4 lin. broad. Panicle up to 1 ft. long 6
6. Panicles 3½-6 lin. thick. Spikelets 2-2½ lin. long ... **P. macrourum.**
Panicles about 3 lin. thick. Spikelets 1½-1¾ lin. long. **P. natalense.**

PENTAMERIS.

1. Valves and pales very broad. Lobes of former broad, short, dentate or abruptly subulate-acuminate ... **P. thuarii.**
Valves and pales narrow. Lobes of former long, narrow, acute, adnate for ½-⅘ of their length to lateral bristles 2
3. Panicle very lax, more or less open ... **P. longiglumis.**
Panicle narrow, contracted 4
4. Spikelets 8-12 lin. long. Awn 9-11 lin. long. Lobes of valve ⅓ as long as body ... ... **P. speciosa.**
Spikelets 6½-7½ lin. long. Awns about 6 lin. long. Lobes of valve ½ as long as body ... ... **P. dregeana.**

PENTASCHISTIS.

1. Panicles eglandular. Spikelets more than 3 lin. long 2
Panicle or leaves or both gland-tubercled, or if eglandular then the spikelets less than 3 lin. long 18
2. Blades ½-1½ in. long, more or less subulate 3
Blades ¼-2 ft. long, filiform, convolute 5
3. Annual. Spikelets 7-8 lin. long. Blades soft. **P. triseta.**
Perennial. Spikelets 3½-4½ lin. long. Blades rigid... 4
4. Axils of panicle long bearded ... ... **P. acinosa.**
Axils of panicle glabrous ... ... **P. elegans.**
5. Basal sheaths at length breaking up into persistent fibres. Spikelets 3-4½ lin. long 6
Basal sheaths not breaking up into persistent fibres... 7
6. Blades setaceous, subterete, glabrous. Awns scarcely exserted ... ..., ... **P. tysoni.**
Blades up to 1 lin. broad when unfolded, pubescent above the ligule. Awns exserted from the glumes ... **P. fibrosa.**
7. Spikelets 3-4 lin. long 8
Spikelets 4-8 lin. long 9

8. Panicle 6 in. by 6 in. effuse. Side bristles 2-2½ lin. long. **P. natalensis.**
   Panicle 2-4 in. flaccid. Side bristles 5-6½ lin. long ... **P. capensis.**
9. Panicle obovate when contracted. Basal sheaths silky tomentose 10
   Panicle oblong to ovoid. Basal sheaths not silky tomentose 11
10. Spikelets 7-8 lin. long ... ... **P. aristidoides.**
    Spikelets 5-6 lin. long ... ... **P. viscidula.**
11. Blades rather broad, flat, or loosely folded 12
    Blades very narrow, filiform, convolute 13
12. Spikelets brownish, straw coloured. Keel of glume smooth. Side bristles of valve stiff, 2-2½ lin. long. **P. pallescens.**
    Spikelets silvery, glistening. Keel of glume ciliate. Side bristles slender, 4-5 lin. long ... ... **P. argentea.**
13. Panicle spike-like ... ... **P. curvifolia.**
    Panicle not spike-like 14
14. Panicle 2-3 in. long. Lax, often scanty. Blades ½-1 ft. long ... ... **P. colorata.**
    Panicle 4-10 in. long, usually dense. Blades 1-2 ft. long 15
15. Sheaths broad. Ligular fringe curved 16
    Sheaths narrow. Blades channelled. Ligular fringe straight 17
16. Spikelets 5½-6 lin. long. Glumes smooth ... ... **P. nutans.**
    Spikelets 4¼-4½ lin. long. Glumes scaberulous on the keel ... ... **P. tortuosa.**
17. Sheaths densely woolly or villous in the upper part, lower often sub-flabellate ... ... **P. eriostoma.**
    Sheaths adpressedly hairy between the nerves, at length glabrous, not flabellate ... ... **P. juncifolia.**
18. Panicle very slender, acute, about 5 ins. long ... **P. lima.**
    Panicle obtuse in the contracted state, or if acute then much less than 5 in. long 19
19. Culms erect, rather stout. Panicle 3-6 in. long. Blades rigid often flat 20
    Culms ascending (or if erect then annual or panicle ½-3 in. long or blades not flat and broad) 22
20. Panicle contracted, rather dense, divisions unequal. **P. zeyheri.**
    Panicle open, lax, all divisions except the ultimate long 21

21. Axis and branches of panicle scabrid, without tubercular glands. Glumes smooth ... ... **P. hirsuta.**
Axis and branches of panicle with tubercular glands. Keels of glumes scaberulous ... ... **P. rupestris.**
22. Annual 23
Perennial 25
23. Spikelets 1¼-1½ lin. long. Anthers ⅛-⅙ lin. long ... **P. airoides.**
Spikelets 2-2½ lin. long. Anthers 1 lin. long 24
24. Panicle lax, divaricate. Blades filiform or involute ... **P. patula.**
Panicle more or less contracted. Blades flat. **P. euadenia.**
25. Spikelets 3-4 lin. long 26
Spikelets scarcely 2½ lin. long 28
26. Blades closely and prominently striate, curling at length. Margins fringed with numerous tubercles. **P. aspera.**
Blades slightly striate not curling. Margins not or scantily tubercled 27
27. Culms densely and distichously leafy at the base. Ligular fringe inconspicuous. Sheaths scantily bearded or beardless ... ... **P. subulifolia.**
Lower leaves fewer or more distant. Ligular fringe conspicuous. Sheaths bearded ... ... **P. leucopogon.**
28. Spikelets 2¼-4 lin. long. Blades firm, filiform or setaceous 29
Spikelets 1-2½ lin. long. Blades soft or flaccid or if somewhat rigid, then very fine or very short ... 33
29. Side bristles 3-4 on each side of the valve ... **P. heptamera.**
Side bristles 1 on each side of the valve 30
30. Spikelets 3¾-4 lin. long. Blades setaceous, glabrous 1-4 in. long ... ... **P. burchellii.**
Spikelets 2¼-3 lin. long 31
31. Lower valve with 3 bristles. Upper with a long kneed awn and 2 bristles ... ... **P. heterochaeta.**
Both valves alike 32
32. Blades very hairy 1-1½ in. long. Glumes pubescent. **P. tomentella.**
Blades glabrous or scantily hairy. 2-8 ins. long. Glumes glabrous ... ... **P. angustifolia.**
33. Panicle very lax, open (at least temporarily) 34
Panicle contracted, usually dense (rarely open in **P. thunbergii**) 37
34. Valves with the lobes gradually passing into bristles. Blades small, hairy ... ... **P. jugorum.**
Valves with the lobes distinct from the bristles 35

35. Culms 3-4 ins. or rarely longer. Blades flat, ½-1 in. long. **P. densifolia.**
Culms 9-18 in. long. Blades 2-6 in. long, finely filiform or setaceous 36

36. Both valves awned; lobes truncate ... ... **P. filiformis.**
Lower valve awnless (usually); lobes acute ... ... **P. imperfecta.**

37. Glabrous. Lobes passing into bristles. Awn short and fine ... ... **P. brachyathera.**
Valves usually hairy. Lobes distinct from the bristles. Awn kneed and exserted 38

38. Panicle 1-3 in. long. Pedicels short ... ... **P. thunbergii.**
Panicle 5 in. long. Pedicels long and fine ... **P. longipes.**

PHALARIS.

Annual. Keels of glume conspicuously winged ... **P. minor.**
Perennial. Keels of glume not or obscurely winged. **P. arundinacea.**

POA.

1. Annual or sub-perennial. Anthers less than ½ lin. long. **P. annua.**
Perennial. Anthers 1 or more lin. long 2

2. Bulbous at the base. Leaves of barren shoots often filiform ... ... **P. bulbosa.**
Not bulbous. Leaves not finely filiform 3

3. Valves glabrous or almost so, not connected by wool. Basal sheaths breaking up into fibres ... **P. binata.**
Valves connected by long copious wool 4

4. Spikelets elegantly variegated. Branches of panicle 2 nate. Panicle lax ... ... **P. atherstonei.**
Spikelets not or scarcely variegated. Branches of panicle 3-6 nate 5

5. Culms compressed. Valves minutely 2 toothed ... **P. bidentata.**
Culms terete or sub-compressed below. Valve entire. **P. trivialis.**

POLLINIA.

Perennial. Culms erect. Veld plant ... ... **P. villosa.**
Annual. Culms delicate, decumbent, rooting. Bush plant. **P. nuda.**

POLYPOGON.

Awn of glumes 2-3 lin. long ... ... **P. monspeliensis.**
Awn of glumes up to 1 in. long. Side nerves of valve excurrent into bristles ... ... **P. tenuis.**

PRIONANTHIUM.

Lateral nerves of the glumes close to the keels. Membranous margins very broad ... ... **P. rigidum.**
Lateral nerves of the glumes more equally distributed. Margins narrow ... ... **P. ecklonii.**

SCHISMUS.

1. Awn of valve 2-3 times the length of the lobes. Anthers ½ lin. long ... ... **S. aristulatus.**
   Valves without or with a mucro, not or slightly exceeding the lobes. Anthers ⅛-⅕ lin. long 2
2. Spikelets narrow. Glumes thin, acute, or acuminate. **S. fasciculatus.**
   Spikelets slightly turgid. Glumes somewhat firm, subobtuse ... ... **S. koelerioides.**

SETARIA.

1. Blades broad and plicately folded when young. Panicle open or almost spike-like 2
   Blades not plicately folded. Panicle spike-like 3
2. Culms 5-12 ft. long. Blades 1-3½ inches broad ... **S. sulcata.**
   Culms 2-3 ft. long. Blades less than ½ in. broad ... **S. lindenbergiana.**
3. Blades deeply sagittate ... ... **S. appendiculata.**
   Blades not sagittate 4
4. Annual. Panicle cylindric often lobed, dense or lax 5
   Perennial. Panicle cylindric always dense 6
5. Bristles of panicle with barbs reversed ... **S. verticillata.**
   Bristles of panicle with barbs pointing upwards ... 6
6. Culms slender weak. Blades 2-6 in. by 1-3 lin. Panicle ½-3 in. by 1½-2 lin. ... ... **S. imberbis.**
   Culms often stout. Blades 6-18 in. by 3-10 lin. Panicle 1½-12 in. by 4-12 lin. ... ... **S. italica.**
7. Lower glume 5, upper 7 nerved 8
   Lower glume 1-3, upper 5 nerved 9
8. Blades 3-4 lin. broad. Tips of bristles thick and blackish. **S. nigrirostis.**
   Blades 1¼-2 lin. broad. Tips of bristles not thickish. **S. gerrardi.**

9. Culms 2-3 noded $\frac{3}{4}$-2 ft. long. Panicle $\frac{1}{2}$-2 in. long ... 10
Culms 3-7 noded 2-6 ft. long. Panicle 2-12 in. long... 11
10. Blades setaceously convolute $\frac{1}{2}$-$\frac{3}{4}$ lin. broad ... **S. perennis.**
Blades folded or flat 1-2 lin. broad (unfolded) ... ...
S. flabellata.
11. Culms very rough for a long distance. Bristles coarse.
S. rigida.
Culms scabrid close to panicle only. Bristles slender.
S. aurea.

SPOROBOLUS.

1. Rachilla produced into a short bristle subtending the floret ... ... **S. subtilis.**
Rachilla long, not produced 2
2. Culms very many noded. Leaves often apparently opposite along culm ... ... **S. pungens.**
Culms 4 noded or less 3
3. Spikelets $1\frac{1}{2}$-$2\frac{1}{4}$ lin. long. Panicle ovate or spike-like, rather dense ... ... **S. centrifugus.**
Spikelets $\frac{1}{2}$-$1\frac{1}{4}$ lin. long. Panicle lax, or if dense then long and narrow 4
4. Culms from a few inches to 1 ft. long. slender, few noded 5
Culms 2-4 ft. long. rather robust, 2-4 noded 11
5. Culms with a dense tussock of fibres at base ...
S. festivus var. **stuppeus.**
Culms not with a dense tussock of fibres at the base 6
6. Valves 3-nerved, exceeding the glumes 7
Valves 1-nerved, about as long as upper glume ... 9
7. Panicle contracted, somewhat spikelike. Spikelets pallid. 1 lin. long ... ... **S. albicans.**
Panicle effuse or lax. Spikelets purplish, $\frac{5}{8}$-$\frac{7}{8}$ lin. long 8
8. Culms 2-6 in. long, 1 noded. Testa mucilaginous ...
S. tenellus.
Culms 9-12 in. long, 2-3 noded. Testa not mucilaginous.
S. acinifolius.
9. Blades denticulate, fimbriate ... ... **S. discosporus.**
Blade margins smooth 10
10. Rhizome creeping. Barren shoots very short, cylindric, distinct ... ... **S. ludwigii.**
Rhizome oblique. Barren shoots much longer, in compact tufts ... ... **S. ioclados.**
11. Upper glume slightly exceeding $\frac{1}{2}$ valve ... ... **S. indicus.**
Upper glume equalling or slightly exceeding the valve 12

12. Panicle at length rather lax. Blades mostly flat, 3-4 lin. broad ... ... **S. rehmanni.**
Spikelets crowded on the branchlets, often secund. Blades narrower, convolute ... ... **S. fimbriatus.**

STIPA.

Annual. Blades fine. Panicle spike-like. Awns long, intertwisted ... ... **S. tortilis.**
Perennial. Blades flat. Panicle large. Awns short, twisted at base only ... ... **S. dregeana.**

TRAGUS.

Uppermost internode long exserted. Anthers 1 lin. long. **T. koelerioides.**
Uppermost internodes enclosed. Anthers $\frac{1}{6}$-$\frac{1}{8}$ lin. long. **T. racemosus.**

TRICHOLAENA.

1. Spikelets glabrous ... ... **T. glabra.**
Spikelets pubescent or villous 2
2. Upper glume and lower valve 2-3 lin. long, gibbous at or below the middle 3
Upper glume and lower valve 1 lin. long or rather longer, not gibbous 5
3. Blades setaceous ... ... **T. setifolia.**
Blades flat, rarely convolute 4
4. Spikelets silky, villous ... ... **T. rosea.**
Spikelets adpressedly or scantily hairy ... ... **T. brevipila.**
5. Spikelets loosely villous. Lower glume about $\frac{1}{2}$ as long as spikelet ... ... **T. capensis.**
Spikelets pubescent. Lower glume minute ... **T. arenaria.**

TRICHOPTERYX.

1. Spikelets 2-3 lin. long. Valve of male floret long bearded below the middle ... ... **T. dregeana.**
Spikelets 3-7 lin. long. Valve of male floret pubescent, not bearded except at the callus 2
2. Suffrutescent. Valve of male floret sub 7 nerved ... **T. ramosa.**
Not suffrutescent. Valve of male floret 3 nerved ... 3
3. Valve of hermaphrodite floret 7-5 nerved. Callus 2-toothed at the base ... ... **T. simplex.**
Valve of hermaphrodite floret distinctly 9 nerved. Callus very acute ... ... **T. flavida.**

TRIRAPHIS.

1. Perennial 2
   Annual 3
2. Culms many noded, profusely branched. **T. ramosissima.**
   Culms about 3 noded simple ... ... **T. rehmanni.**
3. Valves ¾ lin. long. A dwarf grass ... ... **T. nana.**
   Valves about 1½ lin. long 4
4. Culms 5-7 noded. Middle awn about twice length of the valve ... ... **T. elliotii.**
   Culms 1-2 noded. Middle awn about as long as valve 5
5. Culms with scattered, long, spreading hairs. Glumes smooth ... ... **T. fleckii.**
   Culms glabrous, scaberulous or sometimes scantily hairy. Glumes scaberulous ... ... **T. purpurea.**

TRISTACHYA.

1. Glumes glabrous ... ... **T. rehmanni.**
   Glumes hairy with bristle-bearing glands 2
2. Glumes equal, 10 lin. long ... ... **T. biseriata.**
   Glumes unequal, lower 9-12, upper 14-18 lin. long ... **T. leucothrix.**

UROCHLAENA.

Culms 3-4 in. long, 3 noded ... ... **U. pusilla.**
Culms 4-6 in. long, 4 noded (perhaps only a robust variety of **U. pusilla**) ... ... **U. major.**

VULPIA.

Uppermost internode enclosed. Upper glume 1 nerved. **V. myurus.**
Uppermost internode long, exserted. Upper glume 3 nerved ... ... **V. bromoides.**

III.—Ecological Notes on the Principal Species in each Genus.

In this section it is my purpose to set forth the principal facts that have been ascertained, regarding the part played by all the more important species in the grassland plant succession, and also by means of selected examples, to illustrate the general differences, which are shown in morphological characters, and particularly in leaf anatomy. Much may be learned by studying simple transverse sections of the leaves of grasses. It is much less laborious, and probably even more useful on the whole than elaborate chemical analyses of the herbage, for these without doubt vary greatly according to the time of the year, and even according to the state of the weather. Leaves which after a spell of dry sunny weather may be found full of storage food, may, after a few weeks of rainy, cloudy weather, contain relatively little starch. Farmers have repeatedly expressed the opinion to me that during the past season of exceptional rains, and cloudiness with low temperatures, the veld grasses, though they grew well, especially in the drier low veld, were less nutritious than usual. Chemical analyses therefore to be of value should be repeated at intervals throughout the season, and this, so far as I am aware, has seldom been done.

In attempting to gauge the feeding value of a grass from its ecological behaviour and its morphological appearance, it should be remembered that there is a very close connection between the two processes of transpiration (or loss of water) and carbon assimilation, since the stomata are involved in both processes. Water is lost through the stomata and carbon dioxide is taken in through the stomata. Now a grass which is forced to protect itself against excessive transpiration (*i.e.*, a xerophytic grass) must at the same time be hampered in its carbon assimilation. Xerophytic grasses therefore cannot grow so quickly, and are not so valuable for pasturage as the more mesophytic types. There are few general rules of this kind which do not admit of exceptions, however, and some xerophytic grasses, *e.g.*, *Danthonia purpurea* (see Fig. 9), though their leaf surfaces are greatly reduced, tend to become some-

what succulent, and though slow-growing this species of *Danthonia* is a very nutritious grass. The same applies to other Western and xerophytic species.

Another feature of xerophytes is a tendency towards increased lignification. The leaves become very hard, having developed a large amount of fibre or sclerenchyma. Even though they sometimes contain a fairly high percentage of starch and proteids, etc., cattle dislike them, and refuse to eat them, if they can get any other kinds. It is very noticeable how they eat out the more mesophytic species first, from mixed Veld. In the various figures of leaf sections here reproduced the sclerenchyma is shown by cross hatching. A glance is sufficient to show whether each grass represented is likely to prove palatable to stock. The less cross-hatching shown, the more useful the grass from this standpoint.

All the ordinary grasses have their veins or vascular water-conducting strands parallel. These may be seen by holding the leaf up to the light. The principal veins lie underneath more or less prominent ridges which have furrows between them. Some leaves have a midrib which is larger than the other veins, others do not. A comparison of the figures will show that the ridges are very prominent in the more xerophytic grasses like *Aristida*, and in all the temperate types like *Achneria*, *Lasiochloa*, *Pentaschistis*, *Ehrharta*, *Danthonia*, *Brizopyrum*, while they are much less prominent or almost obsolete in the sub-tropical tribes of the Andropogoneae, Paniceae, etc. (*Andropogon*, *Anthistiria*, *Urelytrum*, *Setaria*, *Tricholaena*, *Panicum*, *Digitaria*, *Sporobolus*, *Harpechloa*, *Chloris*). The sections also show that there are often one or two smaller vascular strands in the hollows between the larger ones. The arrangement of the sclerenchyma is also interesting. It usually lies above and below the main veins, *i.e.*, on the ridges and opposite to them on the lower side. In the mesophytic types it does not join up to the vascular bundles, but in less mesophytic types it forms a girder, which crosses the leaf, the vascular strand lying in the middle of the girder. In still more xerophytic species (*e.g.*, *Aristida bipartita*, *Danthonia disticha*) it forms a continuous band along the lower surface. Attention should also be directed to the presence or absence of hairs on one or both surfaces of the leaf, to the relative thickness or thinness of the cuticle, to the nature and size of the epidermal cells where these are shown, to the arrangement of the green chlorophyll tissue, and to the general outline of the section.

Particular attention should be directed to the way in which the leaf is folded. Some of the xerophytic forms are permanently folded, *e.g.*, *Danthonia*, some of the more mesophytic ones are permanently flat, *e.g.*, *Anthistiria*, *Digitaria*, etc., but intermediate between those are a large number which have their leaves flat and unfolded under moist conditions, and folded on the midrib (conduplicate), or rolled in from the margins (convolute), in dry weather. In such leaves some of the cells of the upper epidermis (either those above the midrib, or those in each of the hollows between the ridges) are larger and thinner walled. When they are full of water and turgid, as is the case when their water supply is not restricted, they keep the leaf unfolded or the ridges apart. In dry weather, however, they lose water and more or less collapse, which has the effect of drawing the two halves of the leaf blade together or causing it to roll inwards from the margin. The experiment may be tried with *Eragrostis curvula*, which is so common along the roadsides in Spring. Pick a few leaves of it when they are flat and expanded and allow them to lie for a few minutes in the sun. They very soon roll up from the margins. In such grasses the thin-walled cells referred to are known as "motor cells." Similar thin-walled cells occur on the leaves of *Andropogon*, *Digitaria*, *Setaria*, which do not, at any rate readily, fold or roll up. In this case they do not function so much as motor cells, but rather as water storage cells. An examination of the figures will show that in such cases the water storage cells are more numerous, covering in some cases most of the upper surface, and there are no prominent ridges. There are other more minute points of structure in grass leaves which are fairly constant, and are useful for the purpose of distinguishing species by their leaves, but it is not my purpose to discuss these at the present time. The chief species will now be dealt with individually, the genera again for the sake of convenience of reference being arranged alphabetically.

Achneria. (See Fig. 1.D.) A temperate genus found chiefly in the South Western region. It differs from *Pentaschistis* in being awnless. *A. capensis* is an important species in the early stages of the xerosere. It invades moss carpets on bare sandstone or granite rocks, and remains for a short time dominant. *A. ecklonii* and *A. ampla* favour marshy or wet sandy soils, and belong rather to the hydrosere. The others occur sparsely scattered among the Macchia shrubs of the S. West, and are of little importance in the plant succession.

Three species, viz., *A. microphylla*, *A. hirsuta*, and *A. setifolia* have a more eastern distribution, being characteristic of the Karroo mountains, and the Stormberg and Drakensberg. *A setifolia* sometimes forms small societies on the flat dry plains of the Eastern Karroo, and transitional belt between that and Eastern Grassveld, and is a good grazing grass. All the species of Achneria are very xerophytic with narrow, short, folded, or setaceous leaves, and deep roots. The spikelets are more or less shining or glistening. The cross section of a leaf of *A. capensis* is shown in Fig. 3. Note the abundant sclerenchyma, which forms large girders, the pro-

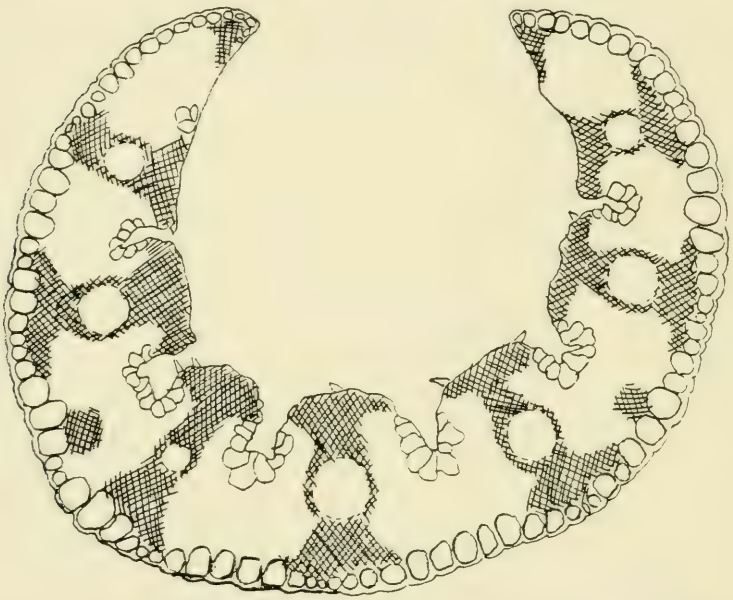

Fig. 3.—Transverse Section of a leaf of *Achneria capensis* (x about 120).

minent ridges and motor cells, the thick cuticle and the large lower epidermal cells. There is no definite midrib. The unshaded portions between the girders is all green chlorophyll tissue, usually found packed full of food. There are no smaller vascular strands between the main ridges.

Agropyrum distichum. A ruderal species. Leaves with unequal ridges and motor cells. Blades sub-pungent.

Agrostis. Chiefly a temperate genus. The most important species ecologically is *A. lachnantha*, which occurs all

over S. Africa in Vleis, and near stream banks, and is often dominant in patches forming socies in the hydrosere. *A. suavis* forms definite societies in the Mountain Veld of the Drakensberg around Van Reenen's Pass. *A. bergiana* is an annual, common at the Cape and extending to Natal. *A. verticillata* is ruderal at the Cape, and *A. griquensis* is an annual only recorded for Griqualand West. *A. natalensis* is a rare Natal species. The leaves of most species of *Agrostis* are usually flat with numerous unequal ridges, with only small patches of sclerenchyma at the apex of each ridge.

Aira caryophyllea (Silvery Hair grass). Found in sandy places or ruderal in the South West. Introduced.

Ammophila arundinacea (Marram grass) has been planted on sand dunes along the coast.

Andropogon. (See Fig. 1 G and Fig 2 E.) Following the arrangement of Hackel, and that by Stapf in the Flora Capensis, I have not adopted any sub-division for this large genus, which is on the whole the most important in South Africa, especially in the climax stages of Eastern Grassveld. Ecologically the genus may be divided into several distinct groups. The sub-genus *Sorghum* contains *A. halepensis*, which is chiefly ruderal or hygrophilous, and the nearly allied *A. sorghum* with its numerous varieties (Kafir Corn or Amabele and imFe), which is widely cultivated by the natives. These two species are very distinct. Another small group is confined to the semi-open veld, or dry rocky hillsides of the centre and west, *viz.*, *A. monticola* var. *trinii* from Bechuanaland, which is noted by Stapf as also occurring in India, *A. ischaemum* var. *radicans*, *A. schinzii*, and *A. annulatus*.

All the others are typically Eastern Grassveld types, though *A. hirtus*, *A. nardus* var. *marginatus* and *A. eucomus* occur sporadically among the Macchia shrubs of the South Western region. In climax grassland of the Eastern side the most important species is *A. hirtus* (inTunga) which forms large consociations or associations with *Anthistiria*. *Andropogon ceresiaeformis* is only slightly less important, being often associated with *Anthistiria*, and sometimes dominant.

The other species which form societies in the Grassveld are *A. contortus*, *A. schirensis*, *A. amplectens*, *A. eucomus*, *A. nardus* var. *marginatus*, *A. schoenanthus* var. *versicolor*, *A. hirtiflorus*, *A. filipendulus*, *A. transvaalensis*, or the

Grassveld may consist of a fairly intimate mixture of several of them. *A. appendiculatus* is usually a mountain species and *A. intermedius* var. *punctatus* and *A. pertusus*, which agree in having the lower glume pitted, occur usually in the early stages of sub-seres, but may be found in more stable Veld.

The majority of the species belonging to the sub-genus *Cymbopogon* are taller and coarser and represent a type which is either transitional to Forest or Scrub, or which forms a stage in the hydrosere. The commonest are the Dobo or Tambookie grasses *A. nardus* var. *validus* (isiQunga), a lemon-scented grass, *A. auctus* and *A. dregeanus* (uQunga). *A. dichroos* is an early flowering tall growing species often ruderal. *A. cymbarius* is similar but flowers late. Its variety *lepidus* (=*A. tamba* Torre and Harms) belongs to the hydrosere, being found around the margins of Vleis.

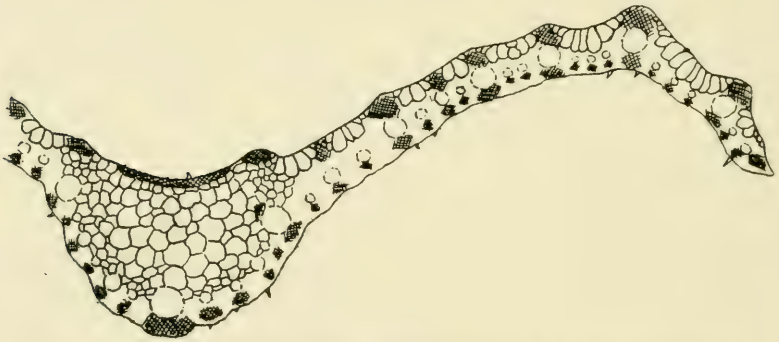

Fig. 4.—Transverse Section of a portion of a leaf of *Andropogon hirtus* (x about 60).

The genus *Andropogon*, being a sub-tropical type, does not show the extreme xerophytism of the South Western and Western semi-desert species. The species have mostly spreading root systems, and tufted habit, growing in strong bunches or clumps. The innovation shoots are either extravaginal or intravaginal or both. The leaves are flat or folded conduplicate. They agree fairly closely with the species here illustrated *A. hirtus* (see Fig. 4). Ridges are not prominent, but there is a very distinct midrib, with large water storage cells. The vascular bundles are more than half surrounded by chlorenchyma, and are not strongly girdered, but they have sclerenchyma both above and below. The thin-walled cells between the patches of sclerenchyma on the upper surface

function rather as water storage cells than as motor cells, but the leaf may fold from the midrib. It does not roll up from the margin. There are one or two smaller bundles between each pair of main vascular bundles. *A. hirtus* is a good grazing grass, having little sclerenchyma. It is also used for thatching.

Anthephora pubescens occurs on rocky hillsides of the central and northern parts Griqualand West, Transvaal, Basutoland and Bechuanaland. The other species *A. hochstetteri*, *A. undulatifolia*, *A. schinzii* are all Western.

Anthistiria imberbis (= *Themeda triandra* Forsk) (Rooi gras or Red grass, inSinde). The most important grass in South Africa. Stapf distinguishes three varieties, *viz.*, *mollicoma*, with leaves, spathes, and involucral spikelets densely villous, *argentea*, leaves silvery, spathes and involucral spikelets glabrous or scantily hairy, and *burchellii* with a panicle laxer than the type, spathes longer (often up to 2in. or more), fascicles of 2-3 racemes only, involucral spikelets 4-6 lin. long glabrous or sub-glabrous. Hackel has another variety *glauca* which probably represents the dry valley or Low Veld type "Blue grass." All the varieties with intermediate stages may be found growing together. *Anthistiria* is dominant over most of the Eastern Grassveld, forming either pure consociations, or associated with various Andropogon species, *e.g.*, *A. hirtus*, *A. ceresiaeformis*. It forms a fairly close covering over the surface of the soil. Its innovation buds are intravaginal, and it does not withstand burning well. Its seeds prefer germinating in shade, as it rarely colonizes bare soil, but rather comes up in the middle of a tuft of some pioneer species like *Aristida* or *Eragrostis*. Its roots are rather shallow and spreading. It ousts the *Aristida* and *Eragrostis* species, partly by shading and smothering them, partly by depriving them of their water supply, through its roots growing above theirs. Under moister conditions it gives way to various Cymbopogons (Tambookie grasses), which grow still taller, and form a type of grassland which is transitional to Bush. *Anthistiria* being such a variable type is able to adapt itself to widely different climatic conditions. It is fairly common, and forms small clans or societies among the Macchia shrubs of the South West. It is dominant over most of the Eastern High Veld, growing 2-3 feet tall, and flowering very freely. In the drier valleys of the Low Veld it forms a dense glaucous covering of herbage, a foot or so

high, and does not flower so freely, though it flowers earlier. On the whole it should be ranked as a moderately mesophytic type. It is a very good grazing grass, but it varies somewhat in this respect also. The glaucous "Blue grass" variety is considered more valuable than the typical Red grass. Fig. 5 shows a transverse section of a rather narrow leaf of *Anthistiria*. It is very similar to the Andropogons. There is a very distinct midrib, which enables the leaf to fold (conduplicate) in dry weather. The ridges are nearly obsolete, and between them are large epidermal water storage cells which do not function as motor cells. The leaf therefore does not roll up from the margins. The main vascular strands are girdered by sclerenchyma above and below, but the total amount of fibre is not excessive.

Fig 5.—Transverse Section of a portion of a leaf of *Anthistiria imberbis* (x about 60).

Anthoxanthum. Two species *A. dregeanum* and *A. tongo* are South Western, and the third *A. ecklonii* is a Mountain Veld species of the Transitional belt and Eastern side. It grows in isolated tufts or tussocks. Like the European *A. odoratum* this grass is sweet scented.

Aristida. (See Fig. 1 F.) The most important genus in the early stages of succession, throughout South African grassland, and dominant over enormous areas of open or semi-open grassland or semi-desert of the Western side. As Stapf has pointed out the genus *Aristida* contains two ecological types, one a desert type, recruited chiefly from the section Stipagrostis, which has 3 nerved glumes and plumose awn bristles, and the other a steppe type from the sections Chaetaria and Arthratherum, which have 1 nerved glumes and glabrous awns, but the two types merge into one another.

On the great sandy plains from South West Africa and Namaqualand through Calvinia, Gordonia, and Prieska the Toa grass *A. brevifolia* a very xerophytic, suffrutescent species, covers great areas. Other important semi-desert species of the West are *A. ciliata*, *A. obtusa*, *A. namaquensis*, *A. subulicola*, *A. uniplumis*, *A. dregeana*, *A. hochstetteriana*, *A. subacaulis*. The only characteristic species in the Cape region is *A. capensis*. In the Karroo, and in the transitional belt between Karroo and Eastern Grassveld *Aristida* remains the most important genus, the chief species being *A. congesta* (Steek gras), *A. vestita*, *A. barbicollis*, *A. adscensionis*, *A. bipartita*, *A. stipoides* var. *meridionalis*, *A. ciliata*, *A. proxima*, *A. obtusa*, *A. uniplumis*.

In Eastern grassland Aristida consocies are widespread in the initial stages of the prisere, the chief species being *A. junciformis*, *A. angustata*, *A. congesta*, *A. barbicollis*, *A. bipartita*, *A. aequiglumis*, *A. sericans*, *A. spectabilis*. Through the influence of grass-burning, and over-stocking, Aristida consocies become semi-stable, and often replace climax Anthistiria or Andropogon consociations, forming what W. G. Smith has called "substituted types." They really represent initial or primitive stages of the succession.

The species of *Aristida* are all xerophytic, the semi-desert types extremly so. They have strong, deep roots, and hard, wiry culms. The name "wire grass" is applied to several of them (*e.g.*, *A. junciformis* and *A. barbicollis*) in the same way as the native name "umgongoni." Their leaves are narrow, usually convolute, and very hard. Their fruits ("seeds") are capable of hygroscopic movements. If they are placed on the surface of moist soil they will soon be found to have buried themselves. Some of the seeds, *e.g.*, those of *A. congesta* (Steek grass) bore their way even through the skin of sheep. All this is of importance as showing how they are fitted to act as pioneers, and colonize bare areas. The species usually grow in dense caespitose tufts which give shelter, and a certain amount of shade for the seedlings of less resistant species like *Anthistiria*, which usually comes up through the midst of the clumps. The anatomy of the leaf of *A. bipartita* is shown in Fig 6. The ridges in this case are prominent, with motor cells between them. The leaf folds in dry weather, and there are hairs on the upper surface. The bundles are not girdered, but there is a thick continuous band of sclerenchyma along the lower side, and across each of the

ridges. The most noticeable feature is the very small amount of chlorenchyma. Like all the other species of Aristida this is a very poor grazing grass, full of hard sclerenchyma and with little storage food.

Arundinaria tesselata (the Berg Bamboo). A mountain bamboo growing in clumps usually along watercourses, and at the edge of Bush on the slopes of the Drakensberg around to the Stormberg and Witteberg at altitudes of from 4,000-8,000 feet. It does not enter into the grassland succession, but in places is important in the Bush succession.

Arundinella ecklonii. A tall Vlei species, also marginal to forest. It is widely distributed from the Cape to Natal and the Transvaal. *A. rigida* from the Kamiesberg, Namaqualand is stated by Stapf to be a hairy state of *A. ecklonii.*

Arundo donax. Spanish Reed; introduced. Fairly common in places along streams, but usually near towns or on farms.

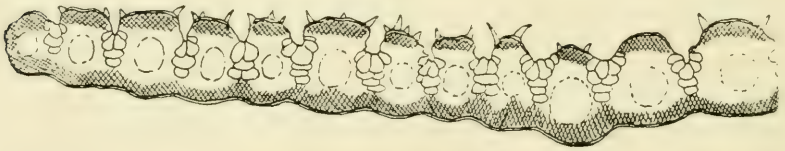

Fig. 6.—Transverse Section of a portion of a leaf of *Aristida bipartita* (x about 80).

Atropis. A temperate genus. The species *A. angusta* is a rare Cape species, collected by Ecklon "in saline places by the Zwartkops river," and the other species *A. borreri* is a native of Western Europe, which occurs in sandy places and dunes at the Cape and in Namaqualand. Dr. Stapf is inclined to think that it is truly native of South Africa, and if so, it is interesting as representing one of the few boreal elements in our flora.

Avena. Oats. Introduced weeds of Mediterranean origin. Common enough all over, but mostly at the Cape. Ruderal.

Avenastrum is another temperate genus, which is represented at the Cape by *A. longum* and its variety *grande* (most abundant), and also by *A. quinquesetum* and *A. dodii. A. dregeanum* is from Little Namaqualand and the others are eastern mountain types. *A. antarticum* extends from the

Cape to Queenstown. *A. caffrum* occurs on rocks on the Witteberg, and its variety *natalensis* is a rare Natal mountain-veld species. *A. turgidulum* is the commonest Eastern Grass-veld species, chiefly in Mountain Veld.

The species of *Avenastrum* are hard-leaved and xerophytic with strong ridges, very similar to the other temperate species illustrated.

Axonopus semialatus var. **ecklonii.** (See Fig. 1 E.) A common Grassveld species of the Eastern side. It forms vernal aspect societies.

Brachypodium. *B. distachyum* is an introduced ruderal species at the Cape. *B. bolusii* is a rare mountain species on the Compass Berg, and the only other South African species *B. flexum*, of which there are several varieties, extends from Capetown to Natal. The variety *simplex* is a mountain type usually in shade in the Drakensberg and other mountains of Natal, occurring rarely at lower altitudes.

Briza. *B. maxima* and *B. minor* are both introduced species widely distributed in South Africa, chiefly ruderal.

Brizopyrum. (Temperate.) All the species are confined to the region of Macchia in the South West. They are all rather rare except *B. capense*, which is common and extends as far east as Port Elizabeth. Its leaf in transverse section is very similar to that of *Achneria capensis*, which has already been described. (See Fig. 3.) All the species of *Brizopyrum* are xerophytic and deep rooted, and they grow rather sparsely scattered.

Bromus. (Temperate.) The four perennial species *B. leptoclados*, *B. natalensis*, *B. speciosus*, *B. firmior* are mostly mountain types, though *B. leptoclados* occurs in the Cape Peninsula also, and *B. natalensis* is recorded for Weenen in Natal. None of them are common, as far as I have seen. The half-dozen annuals are weeds, probably all introduced. The leaves have low ridges and only the larger bundles are girdered.

Calamagrostis epigeios var. **capensis** differs very slightly from the European form. It occurs at the foot of the Witteberg, and in Griqualand West. The leaves have prominent ridges, and the vascular bundles are strongly girdered with sclerenchyma.

Chaetobromus. *Ch. schraderi* is only recorded for Paarden Island, and *Ch. involucratus*, and *Ch. dregeanus* are from Little Namaqualand. They are tufted xerophytic forms.

Chloris. The most widely distributed species is *Ch. petraea*, which extends from the Cape to Natal and the Transvaal. It is a common pioneer in the open veld of stony hillsides. *Ch. pycnothrix* is a very common ruderal in Natal, being found usually along roadsides and footpaths. The other two, *Ch. gayana* (Rhodes' grass) and *Ch. virgata*, are also common ruderals, but they occur in the Veld, and are widely distributed. They are very nutritious grass and make a good hay. They are tropical in their affinities and occur also in Tropical Africa. They only rarely assume dominance anywhere in climax Grassveld, being easily ousted by other grasses. *Ch. petraea* is perennial and flowers early, the others are annual or sub-perennial and flower late. If the Veld grass is burned before they have time to seed they are easily

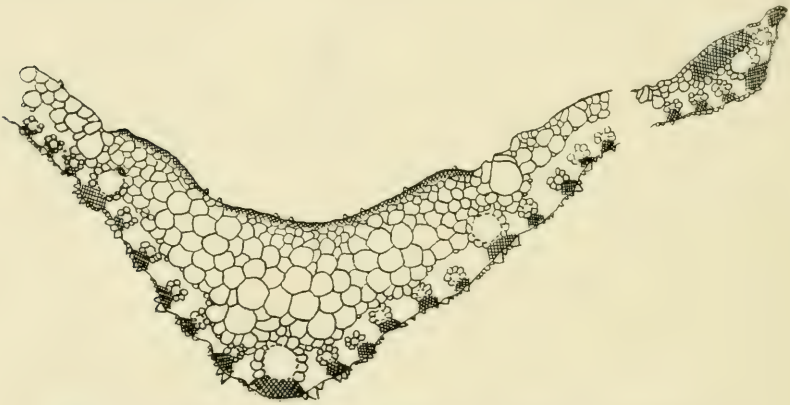

Fig. 7.—Transverse Section of a portion of a leaf of *Chloris gayana* (x about 70).

destroyed, which fact illustrates the way in which early burning leads to deterioration in the quality of Veld Grassland. Other aspects of the same subject will be discussed at length later. Fig. 7 shows the cross section of a leaf of *Ch. gayana*. The chlorophyll tissue is confined to a ring round the vascular bundles. The whole upper half of the leaf consists of water storage tissue, which is free from chlorophyll. There is a distinct midrib, and the leaf folds conduplicate as it dries. There is very little sclerenchyma below each bundle, but the margins of the leaf (see right hand side of the figure) are more strongly fibrous and slightly thickened.

Crossotropis grandiglumis is a very distinctive species with spikelets distant from each other along the numerous,

very rigid, spreading, simple branches of the panicle. A common pioneer on stony hillsides all along the Eastern side, and important in the open Grassveld of the transitional belt around the Karroo extending into Bechuanaland, it is very xerophytic, with short, stout sub-pungent leaves, which rarely exceed 2 inches in length. It is said by the natives to be somewhat poisonous. It is fairly common around the Wonderboom tree near Pretoria.

Ctenium concinnum occurs in Pondoland chiefly. Also in Natal and the Transvaal. Locally frequent to dominant.

Cynodon. The cosmopoliton *C. dactylon* occurs all over South Africa, and is rather variable in its habit. *C. pascuus* is said by Stapf to be only a shade form of *C. dactylon*, but it remains fairly distinct, when cultivated, though the difference is only varietal. *C. incompletus* is one of the most important pioneers in the xerosere all over the Karroo, and the transitional belt, between Karroo and Grassveld. Both species are known as Kweek grasses, *C. incompletus* sometimes being distinguished as "Rechte Kweek gras." The peculiar habit of the Cynodons with creeping stems, which root at the nodes, enables them to take advantage quickly of supplies of surface water, and to colonize bare soil surfaces. They are often ruderal, and everywhere are of importance in the establishing of Grassveld. *C. dactylon* is typical of the "lair flora" of old cattle kraals or abandoned kafir kraals. It often lines pathways, where the soil has been packed hard, and it colonizes old termites nests. Both species are commonly used for making lawns. They are good grazing grasses, and are liked by all kinds of stock, but in a wilted condition, they have been suspected of being the cause of lamziekte in cattle. In cross section the leaves are very like those of *Setaria* illustrated below (see Fig. 18), the main vascular bundles being as a rule separated by three smaller ones. The chlorophyll is chiefly in a ring round each vascular bundle. The grooves between the ridges are very shallow. There is little sclerenchyma, and the bundles are not girdered. The Panicums and Digitarias are all similar.

Cynosurus echinatus (Crested Dog's Tail) is a Mediterranean species introduced into cultivation.

Dactylis glomerata (Cocksfoot) is another European species also introduced, ruderal and cultivated.

Dactyloctenium aegyptiacum (isInane) is chiefly a sand dune and sea shore species along the Eastern coast. It forms

definite associes with *Stenotaphrum glabrum* or consocies by itself between the Psammophilous Bush and the sea, or on sandy flats near the shore. It is a prostrate species, which roots from the proliferously branched nodes, and is sometimes used for making lawns.

Danthonia is another temperate genus chiefly characteristic of the South Western region of Macchia, though a few species have a more eastern distribution. At the Cape the principal species are *D. macrantha*, *D. lanata*, *D. lupulina*, *D. elephantina*, *D. cincta*, *D. stricta*, and *D. curva*, all very xerophytic, hard leaved, deep rooted species, which grow among the Macchia shrubs. In cross section their leaves are somewhat similar to those of *Achneria* and *Pentaschistis* or those of *D. disticha* (see Fig. 8 below). Some of the species

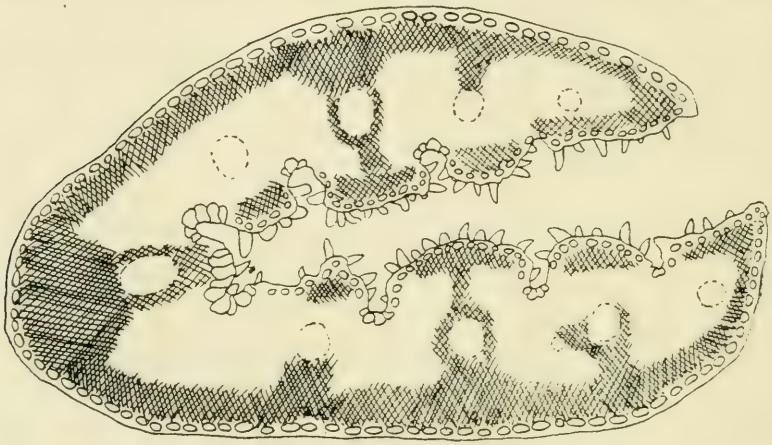

Fig. 8.—Transverse Section of a leaf of *Danthonia disticha* (x about 120).

are only recorded for Namaqualand and the West, *e.g.*, *D. dura*, *D. pumila*, *D. tenella*, *D. glauca*, *D. rangei*. The most interesting, however, are the species which extend Eastward along the mountain ranges and the coast. *D. inermis* occurs at Port Elizabeth, *D. decumbens* in the Amatolas, *D. cincta* on the mountains around Grahamstown, *D. suffrutescens* around Prieska and Carnarvon districts, and *D. stricta* on the Drakensberg. *D. macowani*, or a species very near it, I have gathered in the upper reaches of the Tugela on the Natal side of the Drakensberg.

D. disticha is common on the Stormberg, and mountains around the Karroo. It grows usually among rocks, and is a

very xerophytic form. Fig. 8 shows a transverse section of its leaf. Note the excessive amount of sclerenchyma and the thick cuticle. The assimilating tissue which is the portion shown not shaded, is packed very full of starch. The bundles are strongly girdered below, but not always above. There are ridges on the upper side, but the leaf remains permanently folded. Obviously this is not a palatable grass, but if eaten it is not without nutritive value.

Fig. 9.—*Danthonia purpurea* Beauv. A. Whole plant. B. a single spikelet. C. Lower glume. D. Upper glume. E. Valve, front view. F. Valve, back view. G. Pale. H. Ovary and lodicules.

By far the most interesting of all the species of *Danthonia* is the dwarf *D. purpurea*, the Haas Gras or Hare Grass, which has established itself, ousted *Anthistiria*, and become completely dominant in the grassveld for miles around Molteno in the Stormberg region near the eastern edge of the Karroo.

The causes which have brought this about are discussed more fully later, but here it may be stated that it is almost certainly the result, at any rate to a large extent, of man's interference. *D. purpurea* is a very low growing species, rarely more than an inch or two high, and it may be easily recognised by its long ciliate leaf margins. It has rather deep roots, and the growth form is somewhat spreading with numerous, densely leafy innovation shoots. The leaves are somewhat succulent, and altogether it is peculiarly adapted to growing over the surface of hard-baked clay soils. Its morphology is fully illustrated in Fig. 9.

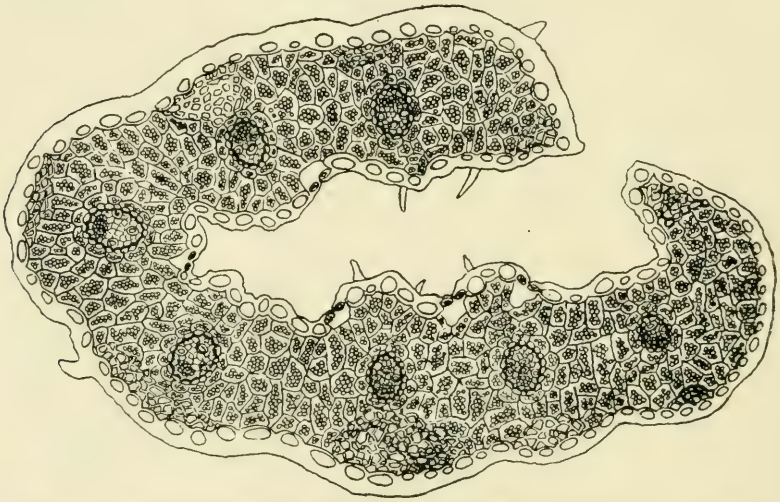

Fig. 10.—Transverse Section of a leaf of *Danthonia purpurea* (x about 120.)

Though in general appearance *D. purpurea* is a very xerophytic plant, farmers are agreed that it is also a very nutritious species. The Veld where this grass is dominant is said to be capable of carrying one sheep per acre, which is at least twice as much as most other types of Grassveld. It stands both frost and drought, and the possibility of its cultivation is worth investigating. It is interesting in this connection to note that, according to J. H. Maiden,[1] in Australia *Danthonia penicillata*, the widely diffused Silver grass or Wallaby grass, is one of the best fodder grasses, while *D. robusta*, a coarse species is the best fattening grass on the Mount Kosciusko plateau. The detailed structure of the leaf of *D. purpurea* is shown in Fig. 10. The leaf is permanently

1. Maiden, J. H. "Australian Vegetation" in the Handbook for Australia (Brit. Assoc.) 1914.

folded like that of *D. disticha*, but there is comparatively little sclerenchyma, and the ridges are not prominent. The stomata are shown on the supper side. On the lower side there is very thick cuticle. The majority of the cells are seen to be packed as full as they will hold with food material. The vascular bundles are not girdered.

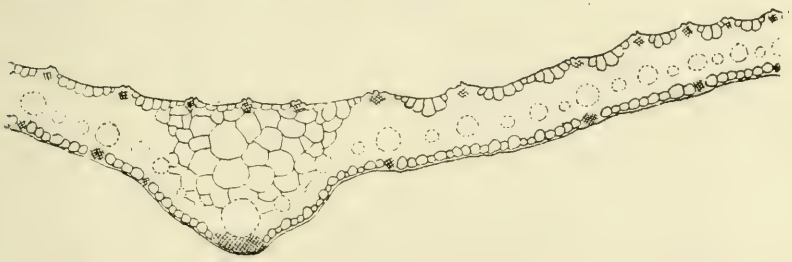

Fig. 11.—Transverse Section of a portion of a leaf of *Digitaria ternata* (x about 60).

Digitaria. This genus is very closely allied to *Panicum*. *D. ternata* is a common early flowering ruderal. *D. sanguinalis* is equally common in autumn and *D. horizontalis* is also abundant then. These are all annuals and are widely distributed. *D. debilis* and *D. tenuiflora* are also annuals, but are somewhat rare, only being found in Natal. *D. monodactyla*, *D. argyrograpta*, *D. eriantha*, *D. setifolia*, *D. diagonalis*, *D. tricholaenoides*, *D. flaccida* are all perennials and belong to the primitive stages of Veld development. None of them assume dominance except very locally, but they are common enough, with the exception of *D. argyrograpta* and *D. flaccida*, which are chiefly Mountain Veld types. Some of the perennial forms are rather xerophytic with filiform or setaceous leaves, *e.g.*, *D. monodactyla* and *D. setifolia*, but the majority are mesophytic, and though they are common weeds in cultivated land are considered very good grazing grasses. There is less sclerenchyma in their leaves than in most other South African grasses as is shown in Fig. 11, which is a cross section of the leaf of *D.ternata*. There is a very definite midrib, but the ridges are almost obsolete. Broad bands of water storage cells occur in the shallow furrows. The epidermis is thin, and there are only very small patches of sclerenchyma above and sometimes below the main bundles. The leaf remains flat. Species of *Panicum* are similar, but show minor differences in the arrangemnt of the sclerenchyma.

Diplachne. *D. fusca* is a hygrophilous species found in Vleis and along stream banks, and widely distributed over

South Africa. *D. biflora* occurs in the High Veld of Natal and the Transvaal. *D. eleusine* is another somewhat rare eastern hydrophilous species, and *D. paucinervis* is confined to the Western region. All the species are coarse, tufted, deep rooted, and of little grazing value.

Ehrharta. This genus is of temperate affinities, and chiefly South Western distribution. Some of the species are common on the coast sand dunes at the Cape, being chiefly characteristic of the psammosere, *e.g.*, *Eh. calycina*, *Eh. brevifolia*, *Eh. uniflora*, *Eh. villosa*. The last-mentioned is

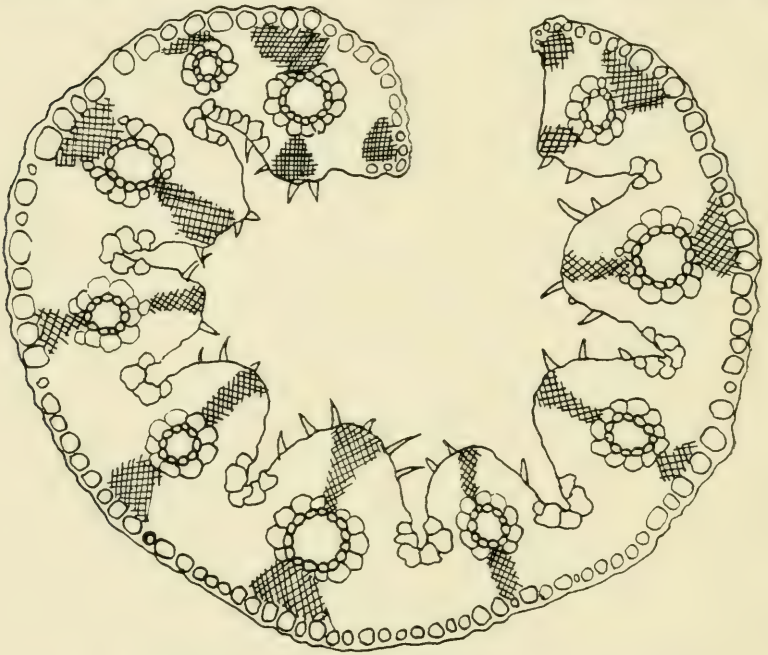

Fig. 12.—Transverse Section of a leaf of *Ehrharta setacea* (x about 120).

common as far east as Port Elizabeth. Several of the species form very definite and sometimes fairly extensive consociations among the Macchia vegetation, *e.g.*, *Eh. setacea*, *Eh. aphylla*, and *Eh. ramosa*. The majority of the 25 species are confined to the Cape, but like so many of the Cape genera, *Ehrharta* includes one or two species which have a wider range. *Eh. calycina*, a very variable species of which Nees distinguished six varieties, extends northwards through the Western region, and eastward through the Karroo and Central region to

Natal, where it is common on the coast sand dunes. *Eh. erecta*, which is often ruderal, has even a wider range extending all through the Central districts to Natal and up through tropical East Africa to Abyssinia, and (probably introduced) into Arabia and very rarely in India. Stapf points out the similar interesting distribution of its nearest relatives in Australasia. The Australian genera *Microlaena* and *Tetrarrhena* are hardly more than dimerous modifications of

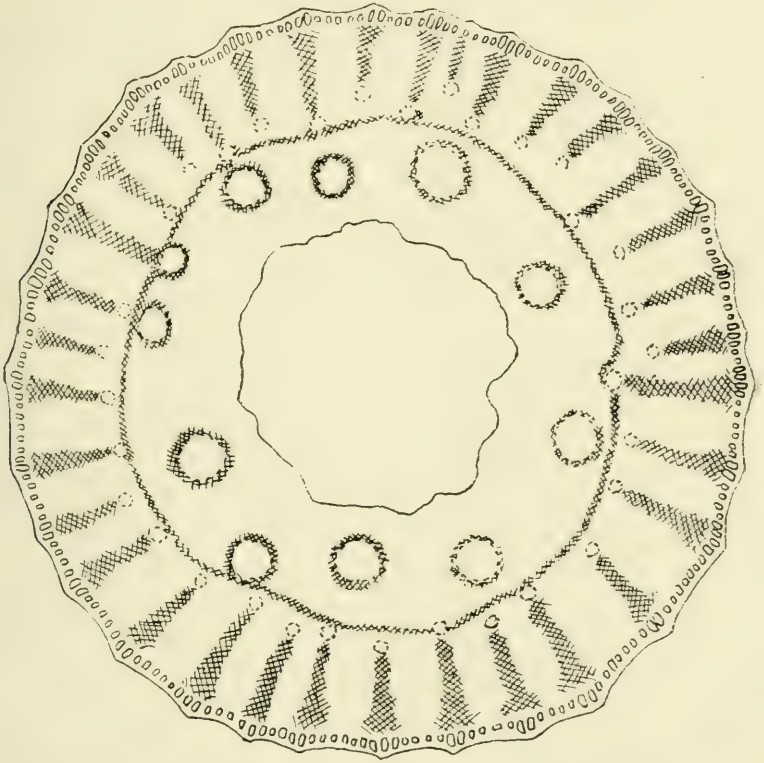

Fig. 13.—Transverse Section of a stem of *Ehrharta aphylla* (x about 80).

Ehrharta. *Tetrarrhena* like the majority of the species of *Ehrharta* in South Africa is confined to the extreme south, in Tasmania and West Australia. *Microlaena*, on the other hand, extends from Tasmania over Australia and New Zealand up to the Highlands of New Guinea.

The species of *Ehrharta* in South Africa, with the exception of the few, which, as mentioned above, grow socially or

subsocially, are found in isolated tufts among the Macchia shrubs. They are all very xerophytic, hard leaved, and deep rooted. Some of them, *e.g.*, *Eh. ramosa*, *Eh. aphylla*, are suffrutescent and leafless, or almost leafless. Fig. 12 represents a section through the leaf of *Eh. setacea*, which is very similar to *Achneria capensis* (c.f. Fig. 3). The ridges are prominent, and the leaf remains folded. The bundles are strongly girdered, and have a single row of sclerenchyma surrounding each, which in turn is surrounded by larger thin-walled cells without chlorophyll. Like *Achneria*, the chlorenchyma shows up very densely packed with food material. The cuticle is thick, especially on the under side, but the epidermal cells are not quite so large as in *Achneria*.

In *Ehrharta aphylla*, which is a leafless suffrutescent species, the assimilating tissue is confined to the stem. Fig. 13 shows its appearance in cross section. The centre as usual is hollow, and a number of large vascular bundles, each surrounded by sclerenchyma, form a circle around it. Outside these there is a narrow continuous band of sclerenchyma, and outside this smaller bundles arranged in an irregular circle, each one being connected with the periphery of the stem by radiating spokes of sclerenchyma. Between these lie the assimilating chlorenchymas. The cuticle is thick and the stem has shallow furrows in which the stomata are placed opposite the radiating rows of chlorenchyma.

Eleusine. *E. indica* (uMunyankomo) (see Fig 2 C.) is one of the commonest ruderal species in South Africa. It sometimes takes complete possession of cultivated land after crops have been reaped. Cattle are fond of it, and it is reckoned quite a good grazing grass. *E. coracana* (uPoko) is very similar, but more robust, and is cultivated by the natives as a cereal, and for making beer, as well as by the white man as a forage grass.

Elionurus argenteus with its variety *thymiodora* is widely distributed over South Africa, except in the West. It is one of the most important species in the climax stages of Eastern grassland, especially northwards in the Transvaal from Wonderboom Poort to the Crocodile River, where it is dominant over great stretches. It is rather xerophytic, with tightly convolute or setaceous leaves and deep roots.

Enneapogon. This genus has its chief centre of development in the open transitional Grassveld, which flanks the

Karroo. Through large areas of the southern Free State Enneapogon-Eragrostis associations are dominant. *E. mollis* and *E. scaber* are the two commonest species, extending westward to Namaqualand and northwards through Bechuanaland. *E. scoparius* belongs to the Karroo and Transvaal, and *E. brachystachyus* to the Free State and Griqualand West, but the latter is also North African. The species are all xerophytic, tufted caespitose forms with narrow linear, often convolute leaves, and deep roots. The panicles are spikelike with numerous awns.

Entoplocamia aristulata. Endemic in Hereroland and Namaqualand, not elsewhere.

Eragrostis. (See Fig. 1 C.) If *Panicum* is understood in the restricted sense as used in the Flora Capensis, then *Eragrostis* is the largest genus in South Africa, and it is, I think, the most difficult from the systematic standpoint, for some of the species are most variable, though others are very distinct. Like *Aristida* it is a very important pioneer genus, being most characteristic of open or semi-open Veld, or of the initial stages of Eastern Grassveld.

Eragrostis spinosa, the Vogelstruis or Ostrich grass, is an extreme desert form, which covers vast areas of sandy soil in the transitional region north and north-west of the Karroo towards Namaqualand. *E. cyperoides* is a litoral sand dune species, which extends along the west coast from Damaraland to the Cape. Three other litoral or sub-litoral, sand dune or hygrophilous species are endemic at the Cape, *viz.*, *E. glabrata*, *E. elatior*, and *E. sarmentosa*. *E. curvula* also occurs at the Cape, but it is common all over. The genus is represented by numerous species in the Western region in addition to those mentioned above, *e.g.*, *E. denudata*, *E. namaquensis*, *E. hereroensis*, *E. porosa*, *E. ramosa*, *E. angusta*, *E. auriculata*, *E. biflora*, *E. brizoides*, *E. brizantha*, *E. lappula* var. *divaricata*, *E. pilosa*, *E. leptocalymma*, *E. longifolia*, *E. retinorrhoea*, *E. superba*, *E. trichophora*, *E. viscosa*, and even this long list, which shows how important the genus is in open Veld or semi-desert, does not include all the species recorded.

On the Grassveld of the Eastern side *Eragrostis* is of supreme importance in all the initial stages of the succession. Throughout the transitional belt between Karroo and grassland, the genus shares dominance with *Aristida*, *Sporobolus*,

Enneapogon, etc. *Eragrostis chloromelas*, *E. curvula*, *E. chalcantha*, *E. micrantha*, *E. obtusa* are the chief species of this open type of Veld. *E. curvula* var. *conferta* (umRrepu-Rrepu) is one of the chief pioneer grasses throughout Natal. *E. chloromelas* is also very common. Both the last-mentioned species flower early. In autumn *E. plana* (umTshiki) is more conspicuous. It forms large associes with *Sporobolus indicus* in primitive Veld, or as the result of grass burning. Its xerophytic, deep-rooted habit is shown by the fact that the early colonists, when on trek, used to look for a tuft of this grass to which they might fasten the fore yoke, when they wished to tether their teams of oxen.

E. chalcantha, a smaller, more rigid species, is also an early flowering pioneer in the High Veld of Natal and the Transvaal. *E. brizoides* is larger and enters into the climax stages of Grassveld as well. Another climax species is *E. gummiflua*, which is associated with *Pogonarthria falcata* (a species sometimes included in the same genus) over the dolomite areas of the Transvaal. Other species which enter into the composition of climax Grassveld include *E. wilmsii*, *E. bicolor*, *E. atherstonei*, *E. lappula*, *E. caesia*, *E. patentissima*. Some of the species belong to the hydrosere, being found in Vleis, *e.g.*, *E. nebulosa*, *E. superba*. On the sand dunes or by streams on the Natal coast, *E. ciliaris* and *E. namaquensis* occur. *E. major* is an annual ruderal species, as is also *E. aspera* in Natal.

The genus *Eragrostis* is peculiarly rich in local endemic species, especially in the Transvaal, *e.g.*, *E. barbinodis*, *E. pallens*, *E. wilmsii*, *E. sporoboloides*, *E. atherstonei*, and in the Free State, *E. echinochloidea*, *E. margaritacea*, and Bechuanaland, *E. dura*. There is no genus which would better repay attention from the systematic standpoint. *E. curvula*, for instance, includes forms which are rather widely different, and some of the other species, *e.g.*, *E. plana* and *E. heteromera*, seem hardly separate.

Ecologically the great majority of the species are xerophytic, but there is greater variation in this respect than in the case of the other great pioneer genus *Aristida*. Some of the species as pointed out above are distinctly hygrophilous. Most of the common species like *E. plana* and *E. curvula* are rather poor grasses from the grazing standpoint, but this rule admits of exceptions, for the Teff grass is an Eragrostis (*E. abyssinica*) and cattle are fond of several other species, *e.g.*,

E. chloromelas, *E. chalcantha*, *E. nebulosa*, *E. brizoides*. Fig. 14 shows a cross section of the leaf of *E. curvula*. There are ridges both above and below, which is unusual and there are smaller ridges between them. There is no very distinct midrib. The sclerenchyma is developed above and below the bundles but these are not always completely girdered. The motor cells in the furrows are functional, and the leaf rolls up quickly in dry weather. The amount of sclerenchyma is not excessive.

Erianthus. *E. capensis*, *E. sorghum* are both tall Vlei species, sometimes also transitional to Bush. Both are known as umTala. *E. junceus* is a Basutoland and Eastern Mountain species. The umTalas are about the tallest of our South African grasses, growing up to 15 feet or more. They are used for thatching.

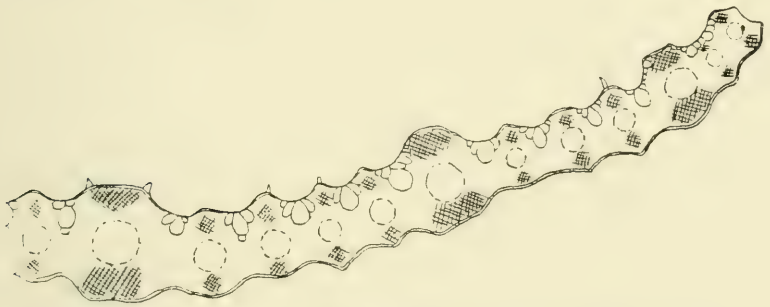

Fig. 14.—Transverse Section of a portion of a leaf of *Eragrostis curvula* (x about 60).

Festuca (See Fig. 1 A. and B.) is a temperate Mountain Veld genus of the Eastern and South Central Mountain ranges chiefly, but *F. scabra*, which is dioecious, occurs all over South Africa. It grows in isolated tufts. *F. caprina* (bok baard) is dominant over stretches of Mountain Veld, and is reckoned rather a good pasture grass. It is fairly common in Natal (though no records are given in the Flora Capensis), and it extends along the Drakensberg to the Stormberg and Amatolas. *F. costata* is similar in its distribution and even commoner, but rarely dominant. *F. longipes* is rare and *F. vulpioides* is only recorded from the Amatolas. The species grow in dense tufts or they form hard tussocks. *F. caprina* is the most xerophytic, with permanently folded filiform or setaceous leaves, and a contracted panicle. The leaves all show more or less prominent ridges in cross section.

Fingerhuthia. *F. africana* (Kalk gras) is a Karroo and transitional species which extends through Griqualand West to the Western region. It is a densely tufted xerophytic form with small, usually convolute leaves. Its roots are very strongly developed. The leaves in cross section show very strongly girdered bundles, with conspicuous motor cells in the somewhat shallow furrows. *F. sesleriaeformis* is a hygrophilous species, and like most Vlei grasses is widely distributed.

Harpechloa capensis (See Fig. 2 B.) is widely distributed from Port Elizabeth through the Free State and Natal to the Transvaal, but though it occurs at various altitudes it is chiefly characteristic of Mountain Veld where it grows in tussocks associated with *Microchloa*, *Festuca*, *Koeleria*, etc. On the Drakensberg it reaches altitudes of 10,000 feet. It has narrow leaves which are flat under moist conditions, convolute under dry conditions. It is a good grazing grass, very much liked by cattle. It is related to *Chloris*, which its leaves resemble in cross section as is shown in Fig. 15. The chlorophyll tissue is arranged in rings around each bundle, and the whole upper half of the section is colourless. There are two or three irregular ridges at the midrib, the rest of the leaf being smooth, and the leaf folds conduplicate but does not roll up. There is a little sclerenchyma below each bundle.

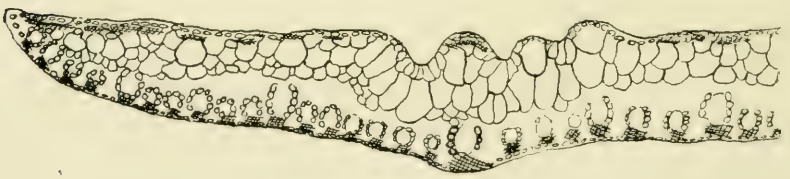

Fig. 15.—Transverse Section of a portion of a leaf of *Harpechloa capensis* (x about 80).

Holcus. Both *H. setiger*, which is annual, and *H. lanatus*, which is perennial, are introduced ruderals. The leaf of the latter is hairy on both surfaces, has rounded ridges with motor cells between, girdered bundles and a thin cuticle. Neither species is common in South Africa, being cultivated only on very poor soil.

Hordeum. *H. secalinum* is rather common in the South West. It is common in the temperate regions of the Northern hemisphere, but is probably not an introduction in South

Africa, for as Stapf points out, in America it extends from the North to Patagonia. In South Africa it is distributed over the South Western and Karroo regions. *H. murinum* is an introduced weed of Mediterranean origin.

Imperata arundinacea. There are two varieties besides the type, *thunbergii* with broader leaves (2-4 lin), and *koenigii* with bearded nodes, and more flaccid leaves, but these varieties, and the type pass into one another. *Imperata* grows in Vleis, or moist sand, and is widely distributed over the whole of South Africa. It often forms consocies in the hydrosere, especially on the coast belt of Natal.

Ischaemum. *I. fasciculatum* var. *radicans* occurs in woods and vleis on the Natal Coast belt. *I. franksae* is a rare mountain species from Tabamhlope, Natal (altitude 6,000-8,000 feet) and *I. glaucostachyum* is a rare Transvaal species.

Koeleria cristata. An extremely variable species which is widely distributed and fairly common. Ecologically it is most important in Mountain Tussock Veld. It varies greatly in its vegetative characters, especially in the hairiness of its leaves, which are narrow linear, flat, or convolute and flexuous, or rigid. In cross section it shows irregular ridges, with well developed motor cells in the furrows. There is little sclerenchyma, and the species is grazed by cattle.

Lagurus ovatus. An annual recorded only for the Cape and the Amatolas It is of Mediterranean origin.

Lamarckia aurea is another small annual, introduced at the Cape, of Mediterranean origin.

Lasiochloa. *L. longifolia* with its two varieties, *hispida* and *pallens*, is common in Namaqualand, and the South Western region generally, extending as far east as Grahamstown, and it has been collected on the Drakensberg by Galpin. *L. ciliaris* is also common in the South West and *L. obtusifolia* is a rarer species from Uitenhage. The species are often ruderal along roadsides and pathways.

Fig. 16 is a transverse section of the left-hand side of a leaf of *Lasiochloa longifolia*. The ridges are unequal as well as the bundles, the larger bundles being below the stronger ridges, and strongly girdered. The smaller bundles are not girdered. There are no very distinct motor cells. There is a thick cuticle on both sides.

Leersia hexandra. A Vlei species with a creeping stoloniferous rhizome, and stems ascending from a prostrate base, rooting from the lower nodes. It is often completely dominant in the early stages of the hydrosere. It is most common on the eastern side, especially in Natal, but it occurs all over South Africa except in the West.

Leptocarydium vulpiastrum, a rare hydrophilous Natal species, found only on the banks of the Tugela and its tributaries.

Lepturus cylindricus. An introduced ruderal at the Cape.

Fig. 16.—Transverse Section of a portion of a leaf of *Lasiochloa longifolia* (x about 70).

Lolium. *L. perenne* and *L. italicum* are cultivated rye grasses. The others are introduced weeds common all over. *L. temulentum* is the commonest.

Lophacme digitata, a rare endemic Transvaal species.

Melica (Temperate). This genus is chiefly characteristic of the central ranges of mountains, but one species *M. racemosa* has a wider distribution from Capetown to Natal. It is found among the Macchia shrubs of the South West, and in open Scrub or rocky places or along roadsides in the Eastern region. *M. decumbens* (Dronk gras) is common on the Stormberg. The other species are rare. *M. bolusii* occurs at high altitudes on the Compass Berg and the Drakensberg, having been collected on the summit of Doodman's Kranz Mountain by Galpin, at 9,650 feet altitude. The species of

Melica are all xerophytic with the culms ascending from slender usually wiry bases. The blades are usually folded conduplicate, c.f. *Achneria*, *Danthonia*, etc., which they resemble in cross section. The species favour open rocky situations on the steep mountain sides. The Dronk gras causes "staggers" in cattle and is said to prove fatal.

Melinis minutiflora var. **pilosa** is a rare Natal species which also occurs in Nyassaland and on Mount Ruwenzori, the type being common in Brazil. Nearly allied to *Tricholaena*.

Microchloa. The two species *M. caffra* and *M. altera* var. *nelsoni* are two of the most characteristic species of Tussock Veld in the Eastern mountain ranges, but the former occurs also in the High Veld. *M. setacea* is a Transvaal species. The leaves are setaceous or subsetaceous in all the species, and are crowded at the base. The old leaf bases persist, forming very hard little tussocks, which collect the soil, and stand up a few inches above the level of the rest of the ground, a feature characteristic of most of the Mountain Veld species. In *M. caffra* the chlorenchyma surrounds the bundles, and the main bundles are girdered. The furrows are filled with large motor cells, and the leaf is folded conduplicate.

Olyra latifolia is a Forest species only known from the Ingoya Forest, Zululand, where it is common.

Oplismenus africanus is another shade-loving mesophytic forest species of the Eastern region, with slender culms straggling up from a long decumbent rooting base like several species of *Panicum* which share its habitat. There are two varieties, *capensis* and *simplex*.

Oropetium capense (See Fig. 2 A.) is a very densely tufted dwarf grass, scarcely an inch high with spikelets sessile in small slender spikes. It is common at Sterkstroom, where it acts as a pioneer in the establishing of grassland, and it extends northwards along the boundary of the Karroo to Griqualand West. It also occurs in the Western region in Hereroland. Stapf believes that its affinities are with the Chlorideae near Microchloa, rather than with the Hordeae, which it superficially resembles. The leaves are crowded at the base, the blades being narrow, linear, and usually setaceously folded. A very xerophytic species, in its habit it resembles somewhat the Haas gras (*Danthonia purpurea*).

Oryzopsis miliacea. A native of the Mediterranean, recorded for the Free State. Introduced and rare.

Panicum. This great genus is sometimes taken as including *Digitaria*, *Axonopus* and *Tricholaena*, but even excluding these it is one of the largest in South Africa. Of the forty odd species, only one or two enter into Grassveld of the climax type, though many ruderals are common in the earlier stages of sub-seres in waste land, and are eaten by stock. The Grassveld species either belong to the section Brachiaria with secund false spikes (*P. serratum*), or if the panicle is loose and spreading, the Grassveld species differ from the others in being caespitose in their habit and not trailing or spreading (*P. natalense*, *P. ecklonii*, *P. dregeanum*, *P. minus*).

The most important of these is *P. natalense*, which is fairly common in climax grassland. *P. ecklonii* is an early flowering Mountain Veld species. *P. serratum* is widely distributed from the Cape to Natal and the Transvaal, common enough, but it hardly forms societies. It is often found along footpaths. *P. minus* with its variety *planifolium* is also widely distributed, extending all over the West and penetrating into Eastern Veld only in the transitional belt. *P. dregeanum* is distinctly Eastern, but not very common.

On the other hand, there are a number of species which are very distinctly Western, *e.g.*, *P. brachyurum*, *P. chromatostigma*, *P. colonum*, *P. glomeratum*, *P. mesocomum*, *P. nigropedatum*, *P. numidianum*, *P. rautanenii*, *P. sagittaefolium*, *P. schinzii*, *P. xantholeucum*, and others. It must be remembered that the Western side, though not so tropical at the Eastern side, at the same latitudes, yet does become distinctly so towards the north. The above species are all tropical. Similarly in the sub-tropical parts of the northern Transvaal *P. typhurum*, *P. acquinerve*, *P. nigropedatum*, *P. trichopus*, *P. holubii*, *P. coloratum*, *P. dregeanum* are found.

Panicum maximum is widely distributed over South Africa, but is hardly ever a Grassveld species. There are a number of species which are confined to the coast belt of Natal where they are characteristic of the margins of bush or other moist situations. They are mostly species belonging to the section eu-Panicum, wide spreading trailing forms many noded and often branched, sometimes rooting from the nodes at the base. Among them are included *P. filiculme*, *P. hymeniochilum* with var. *glandulosum*, *P. acquinerve*, *P. perlaxum*, *P. chusqueoides*, *P. laticomum*, *P. zizanioides*, *P. meyerianum*, *P. proliferum* var. *paludosum* (all from section eu-Panicum), and *P. curratum* (sect Vilfoideae) and *P.*

brizanthum (sect Brachiaria). A few species belong to the hydrosere, being distinctly Vlei plants, *e.g.*, *P. crus-pavonis* var. *rostratum*, *P. pyramidale*, *P. stagninum*, *P. deustum*, *P. interruptum*.

There remain the ruderal species which are widely distributed, but chiefly over the Eastern side. They are of most interest to the farmer for many of them are good grazing grasses. The commonest are *P. isachne*, *P. helopus* var. *glabrescens*, *P. trichopus*, *P. crus-galli*, and two (eu-Panicums) with spreading panicles *P. laevifolium* and *P. proliferum* var. *longijubatum*. *P. laevifolium* is an autumn grass, which is of value as making a good hay. It is very common often in cultivated land. There are also a few species which are probably introuced, *e.g.*, *P. miliare*, *P. repens*, *P. capillare*.

With the exception of the tufted caespitose forms like *P. natalense* the majority of the species of Panicum are mesophytic or hygrophilous, and are tropical in their affinities, in fact the majority of them are confined to the frost free localities in South Africa. Their leaves are flaccid and often delicate without much sclerenchyma, and without pronounced ridges, resembling those of *Setaria*, *Digitaria*, *Tricholaena*, or *Tristachya*. The chlorophyll tissue sometimes surrounds the bundles, in other cases it is distributed evenly along the central line, and has water storage tissue above and below. There are often fairly large intercellular spaces.

Paspalum. *P. scrobiculatum* (isAmuyisane) is common as a weed in cultivated land, and also in Vleis in Eastern Cape Colony and Natal. It is eaten by stock, when it is young, but as the seeds begin to mature it becomes poisonous. *P. distichum* is fairly common in the coast Vleis of Natal. Several other species have been introduced, *e.g.*, *P. digitaria* (at the Cape), *P. virgatum*, and most important of all *P. dilatatum*, which has been found to be a valuable grazing and fodder grass. It is widely grown and is capable of holding its own against the indigenous grasses. The Paspalums resemble closely the Panicums of the section Brachiaria with secund false spikes.

Pennisetum. This is typically a Vlei genus, but *P. typhoideum* is cultivated by the natives sometimes and occurs in moist waste land. *P. cenchroides* is also often ruderal, but sometimes occurs on stony hillsides as well as along streams. *P. macrourum* is chiefly South Western and Central, *P. natalense*, *P. sphacelatum*, *P. unisetum* are Eastern, and *P.*

thunbergii occurs all over South Africa. They are all Vlei and stream-bank species, but they rarely assume dominance. They are very like the Setarias, but are easily distinguished by the fact that the bristles fall off with the spikelets. *Pennisetum longistylum* (the Kikuyu grass), a native of East Africa, has recently been introduced into cultivation in South Africa.

Pentameris (Temperate). A distinctive endemic genus nearly allied to *Pentaschistis*, from which it differs only in the characters of the ovary and fruit (see key). It consists of five species which are confined to the Macchia region of the Cape. *P. thuarii* and *P. speciosa* are the commonest. All the species are extremely xerophytic with woody or suffrutescent bases, deep roots, and rigid wiry leaves. They grow in isolated tufts among the shrubs of the Macchia.

Pentaschistis (Temperate). A large endemic African genus of over forty species, separated by Stapf from *Danthonia* by its endemic distribution, habit, and reduction of the florets to 2. Only a few species occur outside South Africa in the tropical parts of the same continent, and in South Africa the majority of the species are confined to the South Western region. Some of the species belong to the early stages of the xerarch succession to Macchia, *e.g.*, *P. tortuosa*, *P. pallescens*, *P. thunbergii*, and *P. angustifolia*. Most of the species, however, occur among the Macchia shrubs at the climax stage as isolated individuals or as small clans or societies, the commonest being *P. curvifolia*, *P. aristidoides*, *P. pallescens*, *P. colorata*, *P. argentea*, *P. capensis*, *P. acinosa*, *P. aspera*, *P. angustifolia*, *P. thunbergii*, and *P. aeroides*.

In Pentaschistis, as in other characteristic Cape genera, there are a few species which have a more Eastern distribution. Around Grahamstown there are *P. curvifolia*, *P. fibrosa*, and *P. longipes;* on the mountains of the Karroo near Graaff-Reinet *P. angustifolia* and in Calvinia *P. heterochaeta;* still further east on the Witteberg at altitudes of 7-8,000 feet *P. jugorum*, on the Drakensberg and Stormberg *P. aeroides*, on Mount Currie near the Natal border *P. tysoni*, and in the mountain regions of Natal itself *P. natalensis*.

Some of the species are confined to that northern outlier of the South Western Flora in the mountains of Namaqualand, *e.g.*, *P. tomentella*, *P. filiformis*, *P. brachyathera*, *P. euadenia*.

Pentaschistis like all the other Cape genera (*Achneria, Danthonia, Pentameris, Avenastrum, Ehrharta, Lasiochloa, Brizopyrum*) shows extreme xerophytism in all its features almost without exception. There are deep roots and filiform or setaceous (sometimes flat) leaves. In a large section (see key) the leaves are gland tubercled. The spikelets are more or less glistening.

Fig. 17 shows a cross section of part of a leaf of *P. curvifolia*. The margins are slightly thickened, and there are prominent ridges. The main bundles are very strongly girdered and the sclerenchyma forms a continuous band along the lower surface. There are smaller bundles which are not girdered. There are motor cells in the grooves, and the cuticle is thick. There is no distinct midrib.

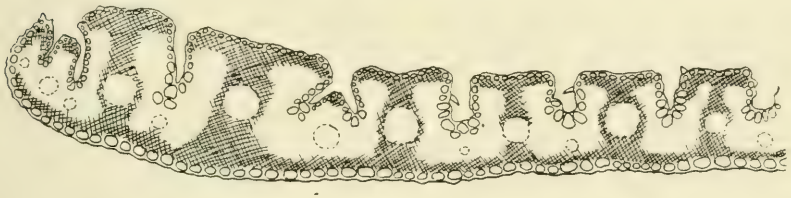

Fig. 17.—Transverse Section of a portion of a leaf of *Pentaschistis curvifolia* (x about 70).

Perotis latifolia, a tropical species found only in S. Africa on the coast belt of Natal, and the northern Transvaal and Amboland, though it extends through the tropics of Africa and Asia.

Phalaris. *Ph. arundinacea* is common in vleis, ditches, and around the margins of Bush. It is widely distributed. *Ph. minor* is an introduced weed, and *Ph. coerulescens* (= Ph. bulbosa) is cultivated for grazing—a valuable grass.

Phragmites communis, the cosmopolitan Reed grass which occurs all over South Africa, and is the most important grass in the hydrosere, often lining the rivers for miles and occurring abundantly in Vleis.

Poa (Temperate). *Poa bulbosa* is only recorded for the West. *Poa atherstonei* is a very rare species from the Compass Berg. *Poa annua, Poa trivialis,* and *Pot pratensis* are all introduced species. The only important South African species

is *Poa binata*, which is common in Mountain Veld. It grows usually sparsely scattered, and it prefers moist spots. It is a very good grazing grass.

Poagrostis pusilla is found in shady, moist places on Table Mountain, Capetown, not elsewhere.

Pogonarthria falcata is associated with *Eragrostis gummiflua* as one of the dominant grasses on the dolomite soils of the Transvaal, and it extends northwards to the Zambesi. It occurs also on the coast belt of Natal.

It resembles species of *Eragrostis*, its leaves folding up convolute. They are often rigid.

Pollinia. The two species of this genus are very distinct. *P. villosa* is rather common in the coast Veld of Natal, and occurs also in the Transvaal and the South West. *P. nuda* is a shade-loving slender, rambling Forest grass, also found in India. It never occurs in the Veld.

Polypogon. *P. tenuis* is South Western extending eastward to the Witteberg. *P. monspeliensis* (Beard grass) is very widely distributed over the whole of South Africa. Both are Vlei or stream bank or moist sand dune species.

Potamophila prehensilis. A shade loving Forest species confined to the coast of Natal. There are only three species in the genus, one in Natal, one in Madagascar, and one in New South Wales.

Prionanthemum. All the species are rare and South Western.

Pseudobromus africanus. Only recorded from the Transvaal Houtbosch.

Rottboellia compressa var. **fasciculata.** A Vlei or stream bank species extending from the Cape to Natal. Not common.

Saccharum munroanum is another Vlei and stream bank species rather rare in Natal and the Transvaal.

Schismus. *S. fasciculatus* is the only common species, and of it there are several varieties. It occurs at the Cape, but it is chiefly characteristic of the drier regions of the West and the Karroo. It is a small tufted annual.

Schmidtia bulbosa (Zand Kweek gras). One of the most important species in the Sand Veld of Griqualand West and

Bechuanaland, also in the Free State and Transvaal. It is xerophytic, with convolute leaves, and numerous villous, conical, innovation buds at the base. Hence it is more or less bulbous. Hackel distinguishes other species, *viz.*, *S. quinqueseta* and *S. pappophoroides*, from various places in the Kalahari, Namaqualand, Hereroland and Amboland.

Scleropoa rigida (= Poa rigida L.), an annual ruderal species introduced at the Cape.

Secale africanum. Collected by Thunberg on the Roggeveld, which, he says, were named after this rye grass.

Setaria. (See Fig. 2 D.) The two species *S. sulcata* and *S. lindenbergiana* of the section Ptychophyllum are very distinct from the others. They have broad leaves which are plicately folded when young. The former is the more abun-

Fig. 18.—Transverse Section of a portion of a leaf of *Setaria nigrirostis* (x about 70).

dant, being usually found round the margins of Forest. *S. perennis* is a Veld species, *S. verticillata* a widely distributed weed, and the rest are Vlei species. *S. aurea* often forms definite consocies in the hydrosere. With the exception of *S. appendiculata*, which is Western only, the Setarias are Eastern in their distribution, being closely allied to the Panicums. Fig. 18 shows the appearance of a leaf of *S. nigrirostis* in cross section. The ridges are not pronounced, and the bundles are not girdered, there being only small patches of sclerenchyma above and below the main ones. There were usually three smaller bundles between the larger. The midrib is distinct, but the large cells in the shallow grooves function as water storage cells and not as motor cells. The leaf remains flat.

Spartina stricta. A European strand and salt marsh plant, only found in South Africa along the seashore at Port Elizabeth.

Sporobolus. (See Fig. 2 F.) This is another important genus of pioneer species like *Aristida* and *Eragrostis*. There is one group of small xerophytic forms, which are particularly characteristic of stony plains and hillsides in the drier regions. *Sporobolus densissimus*, *S. panicoides*, *S. nebulosus*, *S. rangei*, *S. robustus*, *S. virginicus* occur in the Western region. In the Sand Veld region there are *S. tenellus* and *S. acinifolius*. In the Karroo and the transitional belt to grassland *S. ioclados*, *S. ludwigii*, *S. albicans*, *S. discosporus* are the distinctive species. *S. festivus* var. *stuppeus* is a tussock forming species in open or mountain Veld of Natal and the Transvaal. It forms a dense and characteristic stool of old leaf bases which break up into fibres. *S. centrifugus* is a mountain Tussock Veld species, though it is recorded also for the coast belt of Natal. *S. fimbriatus* is important in open transitional Veld chiefly, but it occurs in the Veld of Natal and the Transvaal. *S. rehmanni* is a tropical species of the Transvaal and Natal coast belt, while *S. subtilis* occurs in the latter habitat and also in Madagascar.

Fig. 19.—Transverse Section of a portion of a leaf of *Sporobolus indicus* (x about 60).

The most widely distributed, and also the most important ecologically, is *S. indicus* (umSingizan). It is fairly common among the Macchia of the South West, and is very common as a pioneer species in eastern Grassveld. In Natal the more robust variety *laxus* covers wide areas of primitive Veld, often associated with *Eragrostis plana* (umTshiki). This Sporobolus-Eragrostis associes becomes semi-stable often as the result of continuous grass burning. umSingizan is also common along roadsides and railways. Its leaf is shown in transverse section in Fig. 19. The ridges are not prominent, but there is a distinct midrib. The sclerenchyma is not excessive, and the bundles are not girdered. The motor cells are functional, and the leaf rolls up in dry weather. *Sporobolus indicus* is eaten

by stock especially in Spring, and is cut for hay, but it is not considered a very good grass. The Mountain Veld species, *S. centrifugus,* is better in this respect, but none of the species are of much value.

The species *Sporobolus pungens* is in a class by itself, being the most widely distributed strand plant in South Africa. It extends right round the coast from West to East, and often forms very definite consocies within reach of the salt water. It also occurs in salt Vleis near the coast. It varies a good deal in form, but it may be easily recognized, even when not flowering, by the peculiar many noded culms, which are sheathed all along and have the alternate internodes very short so that the subulate-involute pungent leaves appear sub-opposite. It has a creeping rhizome and is stoloniferous. It is a common litoral species in most warm countries.

Stenotaphrum glabrum is a prostrate creeping grass, which roots at the nodes, and prefers a sandy soil. It is dominant in the hillside flushes very often in the Cape region, and it also forms very definite consocies on moist sandy flats along the coast of Natal. It is used as a lawn grass (c.f. *Dactyloctenium aegyptiacum*). The leaves in cross section show the chlorophyll more or less surrounding the very numerous small bundles, and a large amount of water storage tissue both above and below, which is unusual. There is very little sclerenchyma.

Stiburus alopecuroides is found in moist places or forms consocies in the hydrosere of Eastern Mountain Veld.

Stipa. *S. tortilis* is an annual common in the South Western region and Namaqualand, and *S. dregeana* is a shade loving Bush grass, widely distributed not only in the Eastern Forests, but also in the stream bank Bush of the Karroo and drier regions.

Tetrachne dregei. A Mountain Veld species of the Stormberg. It is sub-dominant in places or forms societies in the Haas gras Veld of the Molteno district. (See under *Danthonia.*) It is a xerophytic form with rigid convolute leaves and low tufted habit.

Trachypogon polymorphus var. **capensis** is common in climax Eastern Grassveld, where it forms autumnal aspect societies. It resembles the Andropogon species with which it mixes. Its leaves are long, narrow, and more or less rigid. The type is found in Tropical and Sub-Tropical America.

Tragus. Both species (*T. koelerioides* and *T. racemosus*) are most characteristic of the open Veld of stony hillsides in the region bordering the Karroo, and also of the Sand Veld region of Griqualand West and Bechuanaland, but *T. racemosus* occurs in similar situations in Natal and the Transvaal. They are small xerophytes, with rather rigid leaves, which have spinulously ciliate margins. The glumes also have spiny hooks. They are reckoned fairly good grazing grasses in spite of their xerophytic character.

Tricholaena. *T. arenaria* is important in the sandy plains of the West, *T. capensis* is from the Central Cape and the Free State, *T. brevipila* from Namaqualand, all being xerophytic species. *T. glabra* is a rare Natal species. *T. setifolia* is an important pioneer in the early stages of grassland over the Eastern side. It grows in compact tufts and has filiform, setaceously convolute leaves. *T rosea* in its perennial forms colonizes stony hillsides, and is widely distributed over the

Fig. 20.—Transverse Section of a portion of a leaf of *Tricholaena rosea* (x about 60).

drier regions from West to East, but the semi-annual forms are peculiarly characteristic of cultivated mealie fields, and waste land generally. It becomes completely dominant and forms a short-lived grass stage in the Sub-sere. Its native name is umKuana. Its seeds have been exported, and it has been grown in India and elsewhere under the name of "Natal Red Top grass," but in South Africa it is not considered to be of much agricultural value. A transverse section through its leaf is shown in Fig. 20. It agrees with *Setaria* and *Digitaria* and *Panicum*. There is a fair amount of sclerenchyma, but the bundles are not girdered. The motor cells are conspicuous, but the leaf is rarely folded even in dry weather, though it rolls up slowly when the plant is uprooted. The ridges are almost obsolete.

Trichopteryx. *T. simplex* with its three varieties, *minor*, *crinita* and *sericea* is common in the Grassveld of Natal and

the Transvaal, and often forms clans or societies. *T. flavida* is a Transvaal High Veld species, and *T. ramosa* is a xerophytic suffrutescent species from Griqualand West. *T. dregeana* belongs to the hydrosere in Natal, being found near streams. It is also recorded for the Transvaal and the Shire Highlands. All the species are tropical.

Triraphis. This is chiefly a Western genus from Namaqualand, Hereroland and Amboland. *T. elliotii, T. purpurea, T. fleckii, T. nana, T. purpurea, T. ramosissima, T. schinzii* are representative Western species of which one or two (T. *fleckii, T. nana*) extend eastward through the Kalahari to Bechuanaland and Griqualand West. *T. nana* is a dwarf annual, scarcely an inch high, and all the species are very xerophytic. *T. rehmanni* has quite a different distribution, from the Cape at Uitenhage through the Free State, Transvaal and Natal. On the eastern side it is a Mountain Veld species or it grows in open stony Veld. No records for Natal are given in the Flora Capensis.

Trisetum pumilum very rare in the South West, probably introduced.

Fig. 21.—Transverse Section of a portion of a leaf of *Tristachya leucothrix* (x about 50).

Tristachya. *T. leucothrix* is widely distributed over the whole Eastern region, and forms definite societies in climax grassland. *T. rehmanni* is common in the Transvaal High Veld and *T. biseriata* is a Basutoland species. They are coarse tufted grasses similar to the Andropogons. Fig. 21 shows a transverse section of part of the leaf of *T. leucothrix*. The ridges are practically obsolete, and there is little sclerenchyma. The motor cells are on the surface, and not at the bottom of grooves, but they cause the leaf to roll up. *Panicum serratum* is similar.

Urelytrum squarrosum. Fairly common in the High Veld of Natal and the Transvaal. It resembles *Trachypogon polymorphus*. The variety *robusta* is larger and stouter. Fig. 22 shows a cross section of the leaf. The ridges are

fairly prominent for a member of the Andropogoneae, and there is a good deal of sclerenchyma, the main bundles being girdered. The leaf folds conduplicate.

Fig. 22.—Transverse Section of a portion of a leaf of *Urelytrum squarrosum* (x about 70).

Urochlaena. Dwarf annual grasses from the sand hills of the Western region. Stapf notes that *U. major* is possibly only a vigorous state of *U. pusilla*.

Vulpia. *V. bromoides* is an annual ruderal introduced species, common at the Cape. *V. myurus* is also annual, in the South West and West, and it has been found in Natal.

IV.—General Sketch of the Grasslands of South Africa and their Development.

1.—SOUTH-WESTERN OR CAPE REGION OF MACCHIA OR FYNBOSCH.

In this well-known region where the rainfall occurs in winter and the summers are more or less dry, the dominant vegetation is of a sclerophyllous type and there is little or no natural grassland, though there are many grasses—nearly 200 species altogether. Some of these are widely distributed over South Africa and are tropical or sub-tropical in their affinities, but such species are of much greater ecological importance on the eastern side. A few of the endemic Cape species are also tropical in their affinities, but the great majority of the grasses of this region belong to the tribes Aveneae, Festuceae and Phalarideae, *i.e.*, they are temperate climatic types. Most of the species are either endemic or only extend eastward along the mountain ranges as far as the Stormberg, or in a few cases to the Drakensberg and Natal. Stapf has pointed out that of the 174 temperate species found in South Africa 121 occur in the Cape Province, and of these 84 are confined to it, and of the 72 Aveneae 58 are endemic. 26 species of *Pentaschistis* and all the 5 species of *Pentameris* are endemic. The other important Cape genera of the tribe Aveneae are *Danthonia*, *Achneria* and *Arenastrum*, of the tribe Festuceae *Brizopyrum* and *Lasiochloa*, and of the Phalarideae *Ehrharta*. The great majority of the species belonging to those genera are confined to the South-West.

The general plant succession in the South-Western region is in outline as follows: The lithosere is extensive and the usual stages are well shown, lichens, xerophilous mosses, fell-field, low-growing heath, and finally a great abundance of sclerophyllous shrubs forming the Macchia. The hydrosere often passes through a stage where Restiaceae are dominant, contrasting with that of the eastern side where Cyperaceae take their place, and the climax—like that of the psammosere on the coast sand dunes—is again Macchia. It is only in a few places where the total rainfall is higher and the summer heat is tempered by South-Eastern mist clouds that forest is developed.

The grasses nowhere play more than a very minor part in the plant succession. Most of the species grow in isolated tufts among the sclerophyllous shrubs, or they form small clans, or at most societies in the climax Macchia. Some of them are shade loving, many are hygrophilous, but the majority are of a very xerophytic type, with deep roots and hard leaves, or the leaves may be reduced, or without leaf blades, *e.g.*, in *Ehrharta aphylla*, *E. ramosa*, etc. A semi-suffrutescent habit is fairly common.

For fuller details regarding the general plant succession Marloth's work "Das Kapland," or a former paper by the writer, should be consulted. Reference to the subject here can only be made in so far as it is necessary to make clear the rôle of the grasses.

A. The Xerosere.

1. The Lichen species which cover bare rock surfaces belong mostly to the genera *Physcia*, *Pertusaria*, *Parmelia*, *Xanthoria*, *Umbilicaria*, *Trentepohlia*.

2. These are followed by various mosses, the more xerophytic species of *Dicranum*, *Campylopus*, *Grimmia*, *Andreaea*, *Brachymenium* acting as pioneers. These hold water and other species come in, the conditions gradually becoming moister, and on flat rock surfaces such as the summit of Table Mountain extensive mats are formed, consisting of one or more of the species *Rhacomitrium incanum*, *Dicranum tabulare*, *Campylopus atroluteus*, *Chanondanthus hirtellus*, *Jamesoniella colorata*.

3. The stages which follow the mosses vary greatly in different places. Various flowering plants grow up through the moist moss mat. Delicate little Utricularias (*U. capense*) are common, looking not unlike moss capsules. There are several kinds of Composite, *e.g.*, *Sphenogyne nudicaulis*, *Cenia turbinata*. In some places *Rochea coccinea* or *R. odoratissima* make a fine display. Numerous small bulbous plants, and species of Oxalis (*O. variabilis*) are common. The full list would be a very extensive one, and the relationship of the species to the moss mat and other environmental factors provides an interesting study.

Among the grasses which appear at this stage, the most important and characteristic species is *Achneria capensis*. It is very common, growing in little tufts intermingling with

the mosses. Several species of *Pentaschistis* come in about the same time, *e.g.*, *P. tortuosa*, *P. pallescens*, *P. thunbergii*, *P. angustifolia*.

4. Soon soil gathers in sufficient depth to support taller species and the mosses disappear. The succession is a very complex one, and in the final stages the Macchia has an extraordinary admixture of species. It is only during the earlier low growing heath stages where it is possible to point to any species such as *Blaeria ericoides* as being dominant. In the same way, with regard to the grasses, it is only in the earlier stages, that any of them grow socially. Of those that do so, the genus *Ehrharta* is the most prominent. In certain ravines of the Great Winter Hoek, *Ehrharta ramosa*—a leafless suffrutescent, very xerophytic, deep-rooted species, is completely dominant, forming an almost pure growth. At the top of Table Mountain, near Maclear's Beacon, there is a grassy flat representing an early stage in the succession with *Ehrharta setacea* dominant and with other species of grasses mixed, viz., *Pentaschistis tortuosa*, *P. thunbergii*, *P. pallescens*, *P. angustifolia*, and a species of *Pentameris*. *Ehrharta aphylla* is very common on Table Mountain, usually among the Macchia shrubs, but occasionally in some of the upper ravines it grows sub-socially. *Danthonia macrantha* sometimes covers rock ledges, and steep slanting rock basins forming small socies.

In the final stages where there is an admixture of hundreds of different species of sclerophyllous shrubs, belonging to the orders Proteaceae, Ericaceae, Restiaceae, Compositae, and to such genera as *Rhus*, *Cliffortia*, *Passerina*, *Psoralea*, and where there are innumerable herbaceous forms also, orchids, bulbous monocotyledons, etc., the grasses are well enough represented, but they grow in isolated tufts. As a matter of fact, hardly any of the Macchia species grow otherwise than in isolated clumps, and the explaining of this characteristic feature in itself presents an interesting problem.

In the tribe Aveneae, which, as already pointed out, is so peculiarly rich in endemic species at the Cape, the genus *Danthonia* includes a number of important species *D. stricta*, *D. disticha*, *D. lanata*, *D. lupulina*, *D. elephantina*, *D. papposa*, *D. cincta*, and *D. curva*. *Pentaschistis* is represented by *P. curvifolia*, *P. aristidoides*, *P. pallescens*, *P. colorata*, *P. argentea*, *P. capensis*, *P. acinosa*, *P. aspera*, *P. angustifolia*, *P. thunbergii*, *P. aeroides*, and other rarer species. The five endemic species of *Pentameris* are *P. speciosa*, *P. thuarii*,

P. dregeana, *P. squarrosa*, *P. longiglumis*. The chief species of *Achneria* are *A. capensis*, *A. ecklonii*, *A. aurea*, *A. setifolia*. Other Aveneae include *Avenastrum longum*, *A. quinquesetum*, *A. dodii*, *A. antarticum*, *Koeleria cristata*, *Prionanthium ecklonii*, *Anthoxanthum dregeanum*, *A. tongo*.

In the sub-tribe Dactylideae of the Festuceae we have what Stapf refers to as the "Brizopyrum group," also containing unusually numerous endemics. The more important ecologically are *Brizopyrum capense*, *B. obliterum*, *B. acutiflorum*, *B. alternans*, *B brachystachyum*, *Lasiochloa ciliaris*, *L. longifolia*. In the Phalarideae, in addition to the species already mentioned the genus *Ehrharta* is represented by *E. triandra*, *E. longiflora*, *E. dura*, *E. microlaena*, *E. bulbosa*, *E. capensis*, *E. longifolia*, *E. erecta*, *E. melicoides*, *E. brevifolia*, *E. calycina*, *E. subspicata*, *E. rehmanni*.

The temperate species have been enumerated first for the purpose of emphasising the fact, that, ecologically as well as floristically, they are by far the most important in the South-Western region. The tropical tribes which are completely dominant over the vast areas of eastern Grass-veld, are poorly represented at the Cape, and the species that do occur are of little ecological importance.

The Andropogoneae here include only a few species, of which *Anthistiria imberbis* is sometimes dominant over small areas. The others are *Andropogon nardus* var. *marginatus*, *A. eucomus* and *A. hirtus*, but these are more frequent as ruderal species, and hardly enter into typical Macchia. The only representatives of the still larger tribe, the Paniceae, are also ruderal. Among the Stipeae the genus *Aristida*, which includes so many semi-desert forms, is poorly represented, though *A. angustata*, *A. adscensionis*, *A. congesta*, *A. barbicollis*, *A. vestita*, *A. ciliata*, *A. capensis*, and *A. namaquensis* occur, but nowhere very abundantly. *Stipa dregeana*, a widely distributed shade loving species, is found in mountain kloofs. In the small tribe of the Zoysieae there are two species, *Tragus koelerioides*, *T. racemosus*. The genus *Eragrostis* (Eragrosteae) is more frequent in the psammosere or early stages of the hydrosere, but *E. curvula*, *E. chloromelas*, *E. chalcantha*, *E. caesia*, *E. obtusa*, and *E. brizoides* occur in the Macchia.

B. The Hydrosere.

1. *Flushes*. These result from the emergence of springs on mountain sides, and may be evanescent. They often dis-

appear after a succession of dry years. In the earliest stages, various Algae and hygrophilous mosses and hepatics are abundant, together with ferns and flowering plants, including orchids. *Juncus lomatophyllus* sometimes forms consocies. The chief grass, which also forms consocies, is *Stenotaphrum glabrum*. Towards the drier edges, *Cynodon dactylon* and various ruderal species occur. Hygrophilous shrubs soon succeed, e.g., *Berzelia lanuginosa*, *Psoralea aphylla*, *P. pinnata*, *Erica curviflora*, *Osmitopsis asteriscoides*, and numerous Restiaceae, e.g., *Dovea mucronata*, *Restio compressus*, *Elegia acuminata*, *Thamnochortus dichotomus*, and the succession soon passes into typical Macchia.

2. *Vleis and Streambanks.* In the early stages of this succession, grasses are common, but once more very rarely dominant. Only some of the species are distinctly South-Western, the majority being widely distributed over South Africa. This is to be expected, since the habitat is, to a large extent, not dependent on climate. The chief species are *Diplachne fusca*, *Agrostis lachnantha*, *Rottboellia compressa* var. *fasciculata*, *Pennisetum thunbergii*, *Agrostis bergiana*, *A. polypogonoides*, *Imperata arundinacea*, *Phragmites communis*, *Phalaris arundinacea*, *Paspalum scrobiculatum*, *Eragrostis nebulosa*, *Erianthus sorghum*, *Polypogon monspeliensis*, *P. tenuis*, and a few more distinctly South-Western *Achneria ampla*, *Danthonia cincta*, *D. macowani*, *Eragrostis sarmentosa*, *E. glabrata*, *E. elatior*, the last three also occurring in the psammosere.

C. The Psammosere.

Along the whole coast line, with certain interruptions, as at Knysna, there are sand dunes, and the plant succession is of course very distinct, though the climax type is again Macchia. The grass *Sporobolus pungens* is one of the most important pioneer litoral species. It extends right round the coast line of South Africa from West to East, often forming large consocies within reach of the spray or liable even to be covered by salt water at extra high tides. *Eragrostis cyperoides* is another litoral grass which grows in large clumps on the dunes from Damaraland southwards along the West Coast to Capetown. The three other endemic South-Western species of Eragrostis, *E. glabrata*, *E. elatior*, and *E. sarmentosa*, grow both on the dunes and in moist spots elsewhere. *Spartina*

stricta is an interesting boreal species, recorded as common along the strand at Port Elizabeth, near the Eastern boundary of the region of Macchia. The following are other litoral South-Western sand dune species: *Panicum distichum* var. *nanum*, *Stenotaphrum glabrum*, *Ehrharta brevifolia*, *E. calycina*, *E. villosa*, *E. uniflora*, *Brizopyrum acutiflorum*.

In the final stages, the sand dunes become covered with sclerophyllous shrubs forming Macchia, among which the following are characteristic species:—*Passerina filiformis*, *Mundia spinosa*, *Psoralea bracteata*, *Myrica cordifolia*, *M. quercifolia*, *Metalasia muricata*, *Othonna parviflora*, *Rhus glauca*, *R. lucida*, *Euclea racemosa*, *Phylica ericoides*, *Chironia baccifera*, *Asparagus capensis*, *A. medioloides*, *Leucospermum uliginosum* and species of *Erica*. As undergrowth, there is a great variety of herbaceous forms, among which the grasses play a somewhat subordinate part. The following occur:—*Andropogon nardus* var. *marginatus*, *A. hirtus*, *Koeleria cristata*, *Achneria ecklonii*, *Pentaschistis aristidoides*, *P. thunbergii*, *P. patula*, *P. curvifolia*, *Danthonia lupulina*, *Polypogon monspeliensis*, *P. tenuis*, *Aristida angustata*, *A. capensis*, *Eragrostis brizoides*, *Melica racemosa*, *Lasiochloa longifolia*, *L. ciliaris*, *Urochlaena pusilla*, *Brizopyrum capense*, *Atropis borreri*, *A. angusta*.

D. Ruderal Species of Grasses.

These are characteristic of waste land or cultivated land, and often mark the initial stages of a sub-sere, being gradually ousted by Macchia shrubs. The stages are the most easily followed of all plant successions. It is noteworthy that the annuals are far in excess of the perennials. Annuals are characterisic of all disturbed habitats, but they are also characteristic of dry or desert regions, where they rest for long periods of drought in the form of seed. The hot, dry summers of the South-West makes the establishing of perennial pioneer species more difficult, since pioneers which colonize new soils or bare areas have no shelter in the early seedling stages. This also leads to an increase in the number of annuals, which though they are common enough as ruderals on the Eastern side are still more so on the West and South-West. Among the ruderals are also included a large number of introduced species. We may therefore classify the ruderal grasses of this region as follows:—

1. Introduced Grasses.

(a) Annuals. *Anthistiria ciliata, Aira caryophyllea, Kocleria phleoides, Trisetum pumilum, Avena sativa, A. sterilis, A. fatua, A. barbata, Lagurus ovatus, Eragrostis major, Phalaris minor, Lamarckia aurea, Cynosurus echinatus, Briza maxima, B. minor, Poa annua, Scleropoa rigida, Vulpia myurus, V. bromoides, Bromus molliformis, B. arvensis, B. commutatus, B. maximum, B. unioloides, Brachypodium distachyum, Lolium temulentum, L. multiflorum, L. rigidum* var. *rottboellioides, Hordeum murinum.*

(b) Perennials: *Paspalum digitaria, Holcus lanatus, Agrostis verticillata, Dactylis glomerata.*

2. South African Species (one or two of them are doubtfully native and ought possibly to have been included above).

(a) Annuals: *Digitaria sanguinalis, Panicum crusgalli, Setaria verticillata, Holcus setiger, Eragrostis aspera, Eleusine indica, Bromus patulus.*

(b) Perennials: *Paspalum scrobiculatum, Sporobolus indicus, Eragrostis curvula, E. brizoides, Chloris petraea, Ehrharta erecta, E. calycina.*

The results of man's interference are seen most obviously in the various places where the above species are common, as in cultivated land, along roadsides, etc. The various sub-seres progress more or less quickly towards the climax type. The influence of man is also shown, however, in a more general way through the agency of fire and through pastoral operations. Goat grazing often has a profound effect on the vegetation. Ostriches do not eat grass, and grasses therefore tend to increase over ostrich farms. Through such influences, especially that of fire, the natural climax vegetation over great areas tends to give way to other types which must be looked upon as initial stages in a new succession (Sub-sere), but which have a certain degree of stability, and remain in possession for long periods, chiefly because the factors that brought them about (grazing, burning, etc.) prevent the new succession from proceeding any further. W. G. Smith has called such types "Substituted types," and, in previous papers I have written about them under the name of "Changed Veld." In the South-Western region, the species which is usually dominant over great areas of this kind is the Rhenoster bosch, a composite (*Elytropappus rhinocerotis*), but certain grasses are also impor-

tant, especially the Kweek grases, *Cynodon dactylon*, and *C. incompletus*. These separately form each extensive consocies and occasionally they mix. *Pentaschistis aeroides*, *Tristachya leucothrix*, *Lasiochloa ciliaris*, *Vulpia bromoides*, and several other South-Western species tend to increase in abundance under the conditions referred to.

The extent of the South-Western region is indicated on the accompanying map, but it is of course impossible to give exact boundary lines. It includes the portion of the subcontinent from Van Rynsdorp southwards to the Cape and eastward to Humansdorp asd Port Elizabeth, being bounded towards the interior by the fold mountains which limit the Karroo. There are, however, low-lying patches of Karroo in the midst of it, and on the other hand there are many South-Western species which extend eastward along the Roggeveld, Komsberg, and Nieuwveld ranges to the Stormberg, and such species while much diminished in numbers often gain in ecological importance. New endemic forms of South-Western affinities appear, and one species of Danthonia (*D. purpurea*) has succeeded in establishing complete dominance in the grass veld around Molteno—a fact which will be fully discussed later. The genus *Melica* assumes great prominence along the above-mentioned mountain ranges.

On the Western side, northwards from Van Rynsdorp, the Karroo type of vegetation occupies the lower altitudes in Namaqualand, but in the Kamiesberg Mountains south of the Orange River, at altitudes of 2,000 feet and over, there is a very distinct outlier of the South-Western flora, and the following grasses all show the affinities with that region, e.g., *Danthonia dura*, *D. tenella*, *Chactobromus dregeanus*, *Pentaschistis lima*, *P. tomentella*, *P. filiformis*, *P. brachyathera*, *P. euadenia*, *Avenastrum dregeanum*, *Ehrharta barbinodis*.

2.—THE WESTERN REGION.

Not having visited this great region, I am unable to enter into any details regarding the plant succession, and for the information here set forth I have had to rely on the writings of Range, Shinz, Pearson, and others. It is fairly clear that it is by no means of such a uniform type as the Macchia of the South-West or even as the Karroo. In the Namib coast belt and also in the whole southern portion of the region, the climate is very dry, rain falling only at long and irregular intervals. The Namib itself is distinct desert, but the moun-

tains to the east of the Namib are not so dry, while towards the north, in Damaraland and Ovamboland, we gradually pass into a distinct tropical, and much moister region, which remains largely unexplored, but which seems to have much in common with the areas of similar latitude on the eastern side of the continent. In all the drier parts mentioned, the vegetation is of an open type, and the plant succession has not progressed beyond the initial stages, which in this case are also the final stages.

An examination of the list of grasses published by Schinz shows that 15 species belong to the Andropogoneae, 40 to the Paniceae, 26 to the Stipeae, and 32 to the Eragrosteae, all of which are tropical or sub-tropical tribes, and between them include over 70 per cent. of the total grass flora. The great South-Western tribes Aveneae, Festuceae, and Phalarideae, are hardly represented. This at once establishes the important fact that the grasses of the Western region, like the rest of the flora, have much closer affinities with those of the Eastern Grass-veld than with those of the Macchia. The most important Western genera are: *Eragrostis* (25 species), *Aristida* (24), *Panicum* (18), *Andropogon* (13), *Pennisetum* (8), *Sporobolus* (7), *Triraphis* (7), *Diplachne* (6), *Setaria* (5), *Anthephora* (4). Total, 117 species, or again nearly 70 per cent. of the whole. If, however, we exclude the distinctly tropical northern portion, from which a large number of new species have been recorded, the numbers are reduced, and by far the most important genus, both floristically and ecologically, is *Aristida*, in fact most of it might be described as Aristida veld. The genus *Aristida*, especially in the species belonging to the section Stipagrostis, is peculiarly a desert type.

A study of the lithosere in this region should prove extremely interesting. Lichen vegetation appears to be more developed here than in any other part of South Africa. In the list of lichens given by Schinz the genera *Amphiloma*, *Blastenia*, *Buellia*, *Combea*, *Lecidea*, *Gasparrinia*, *Parmelia*, *Physcia Pysona*, *Ramalina*, *Roccella*, *Theloschistes*, and *Xanthoria* are represented. The Bryophyta are poorly represented and hardly enter into the plant succession. As far as the grasses are concerned, our information at the present time only permits of a provisional habitat classification as follows:

A. Coast Belt (Coast line and Namib).

(a) Sand-dunes, sandy plains and gravel-flats. *Eragrostis cyperoides*, *E. spinosa*, *E. denudata*, *Sporobolus pungens*, *Aristida ciliata*, *A. dregeana*, *A. obtusa*, *A. sabulicola*.

(b) Stony elevations. *Oropetium capense, Danthonia glauca, D. pumila, Panicum glomeratum, Enneapogon scaber, Aristida ciliata.*

B. Higher Elevations of the Inner Namib.

The outer Western edge of the great escarpment.

(a) Sandy flats. Limestone flats. Sandy dry river courses. *Panicum mesocomum, P. glomeratum, P. coloratum, P. minus* var. *planifolium, Tricholaena arenaria, Aristida adscensionis, A. vestita, A. ciliata, A. namaquensis, A. lutescens, A. obtusa, A. uniplumis, A. brevifolia, A. hochstetteriana, A. sabulicola, Sporobolus sladenianus, Eragrostis spinosa, E. porosa, E. bicolor, E. denudata, E. chalcantha, E. annulata, Triraphis fleckii, T. purpurea, Enneapogon brachystachyus, E. scaber, Schmidtia bulbosa, Fingerhuthia africana, Schismus fasciculatus.*

(b) Rocky mountain slopes. Stony dry river courses. *Andropogon contortus, A. nardus* var. *marginatus, A. plurinodis, Anthistiria imberbis, Digitaria eriantha, Panicum minus* var. *planifolium, Setaria appendiculata, Pennisetum cenchroides, Anthephora pubescens, Aristida adscensionis, A. angustata, A. vestita, A. ciliata, A. geminifolia, A. namaquensis, A. obtusa, A. uniplumis, A. dregeana, Tragus racemosus, Sporobolus ioclados, S. fimbriatus, Eragrostis porosa, E. denudata, E. heteromera, E. annulata, E. brizantha, E. namaquensis, Triraphis ramosissima, Enneapogon scaber, Schismus fasciculatus, Entoplocamia aristulata, Festuca scabra.*

(c) Moist places. Vleis and stream banks. Soil often slightly brackish. *Phragmites communis, Pennisetum macrourum, Polypogon monspeliensis, P. tenuis, Agrostis lachnantha, A. polypogonoides, Diplachne fusca, D. paucinervis, Eragrostis brizoides, Cynodon dactylon, Briza minor.*

C. Central and Eastern Mountain Ranges of the Western Region.

Definite grassland is here developed, which becomes increasingly tropical and mesophytic towards the north. Much of it is Tree Veld of different kinds, of an arid type towards the Namib with Euphorbias and *Aloe dichotoma*; with Acacias (*A. giraffae, A. detinens, A. albida*), *Albizzia anthelmintheca, Dichrostachys nutans, Boscia pechuelii*, etc.,

towards the south and centre; and towards the north with *Hyphaene ventricosa*, *Copaifera mopane*, and other tropical species becoming denser and passing into open forest.

The grasses in the southern portion of this area show that the veld is closely connected with that of the Central and Eastern regions. The chief species are: *Anthistiria imberbis*, *Andropogon contortus*, *A. ischaemum* var. *radicans*, *Eragrostis curvula*, *E. atherstonei*, *E. chloromelas*, *E. lehmanniana*, *Trichopterix flavida*, *Aristida stipoides* var. *meridionalis*, with here and there apparently an admixture of the species named in the previous section.

D. The Northern Portions are, however, so much more tropical, and include so many new species, that they must certainly be considered to form a distinct region altogether. The tribe Paniceae becomes very abundant, and though the genus Aristida is still well represented the species are different. The following are the species for Amboland, recorded by Schinz: *Andropogon contortus*, *A. gayanus* var. *cordofanus*, *A. ischaemum* var. *radicans*, *A. nardus* var. *marginatus*, *A. schinzii*, *Perotis latifolia*, *P. vaginata*, *Tragus berteroanus*, *Panicum brachyurum*, *P. colonum*, *P. laevifolium* var. *amboense*, *P. nigropedatum*, *P. rautanenii*, *P. sagittaefolium*, *P. trichopus*, *P. xantholeucum*, *Tricholaena rosea*, *Setaria appendiculata*, *S. verticillata*, *Pennisetum myurus*, *P. spicatum*, *Aristida alopecuroides*, *A. gracillima*, *A. prodigiosa*, *A. stipitata*, *A. stipoides* var. *meridionalis*, *A. uniplumis*, *Cynodon dactylon*, *Willkommia annua*, *W. sarmentosa*, *Chloris barbata*, *Dactyloctenium aegyptiacum* var. *mucronatum*, *Pogonarthria squarrosa*, *Schmidtia pappophoroides*, *S. quinqueseta*, *Triraphis fleckii*, *T. schinzii*, *Elytrophorus globularis*, *Microchloa caffra*, *Diplachne fusca*, *Eragrostis curvula*, *E. dinteri*, *E. lappula* var. *divaricata*, *E. leptocalymma*, *E. membranacea*, *E. superba*, *E. viscosa*.

It is clear that the Western region is by no means of a uniform ecological (climatic) type. A great portion of it is desert, but there are transitions to a comparatively mesophytic flora in the north. In the south, there are great sandy areas, which as the rainfall increases eastward, pass into the Sand Veld grassland of the Kalahari. Such sandy tracts are, however, interrupted by areas of so-called hard veld with a stony surface occupied by a Karroo flora. Patches of Karroo occur even north of the Orange River, and the boundaries of that region as laid down by Bolus cannot be maintained, in fact,

to attempt to draw any exact boundary lines on a map, at the present state of our knowledge, is altogether undesirable and only leads to misconceptions.

3.—THE SAND VELD OF THE KALAHARI AND CENTRAL REGION.

It is well to explain at the outset that the term Kalahari is here used as on the ordinary maps, and not as a name for a large heterogeneous floral region, including half the Free State and the Transvaal, as it was used by Bolus. The Sand Veld (see map) is a definite grassland type which extends from Prieska and Hopetown northwards and westwards all through the Hay district in the valleys, through Griqualand West, Gordonia, Kuruman, Bechuanaland, and the Kalahari, covering altogether an immense area but with singularly uniform ecological conditions throughout it. The rainfall is not very small, varying from 10-20 inches, and increasing from west to east, but since the whole surface, except in the transitional marginal areas, is covered with sand, there is no surface water and the drainage is underground. The whole area is a great elevated plain, the only mountains being those that surround it, and here and there occasional low elevations of the "inselberg" type. The sand has been blown across from the north-west, and the whole central portion of the area now consists of fixed dunes, which run in a general direction from north-west to south-east. Towards the margins of the area the sand cover gets shallower, and actual dunes are rarer, but the bulk of the country remains sandy.

The South-Western portions of this area are the driest, and consist chiefly of Aristida Veld with the Toa grass, *Aristida brevifolia*, dominant. Other Aristidas which serve as pioneers in the establishing of this type are *A. congesta*, *A. burkei*, *A. ciliata*, *A. vestita*, *A. obtusa*, *A. uniplumis*, *A. mollissima*, *A. stipoides* var. *meridionalis*, *A. spinosa*. The Zand Kweek grass, *Schmidtia bulbosa*, is another characteristic Sand Veld species. With increasing rainfall towards the Eastern side, this grass veld becomes much more mixed until it merges into ordinary High Veld similar to that of the Transvaal, Free State, and Natal. In addition to those mentioned the following species are recorded:—*Andropogon hirtiflorus*, *A. eucomus*, *A. hirtus*, *A. ruprechti*, *A. schoenanthus* var. *versicolor*, *A. monticola* var. *trinii*, *Imperata arundinacea*, *Urelytrum squarrosum*, *Elionurus argenteus*, *Anthistiria imberbis*, *Panicum trichopus*, *P. holubii*, *P.*

isachne, P. coloratum, P. nigropedatum, P. minus, P. serratum, Tricholaena rosea, T. arenaria, Tragus koelerioides, T. racemosus, Sporobolus tenellus, Pogonarthria squarrosa, Diplachne paucinervis, Eragrostis dura, E. denudata, E. leptocalymma, E. pilosa, E. pusilla, E. viscosa, E. superba, E. truncata, E. poa, E. pallens, Cynodon dactylon, Chloris petraea, Ch. virgata, Crossotropis grandiglumis, Triraphis rehmanni, Enneapogon brachystachyus, E. mollis, Schmidtia quinqueseta, Fingerhuthia africana, Oropetium capense.

The tropical and sub-tropical connections of the species composing this veld, is shown by the predominance of the tribes Andropogoneae, Paniceae, Stipeae (*Aristida*), Eragrosteae and Pappophoreae (*Enneapogon* and *Schmidtia*) and by the large number belonging to the genera *Aristida, Eragrostis, Andropogon* and *Panicum*. The tribes Aveneae, Agrosteae, and Phalarideae are not represented, and the Festuceae only by *Fingerhuthia*, which belongs to a sub-tropical section of that tribe, so this veld shows no temperate affinities, and no connection at all with the South-Western region. The connections with the immediately surrounding regions are, on the other hand, fairly close.

The treeless Grass veld of this region in many places develops into Tree Veld. The succession is essentially similar to that in the Thorn Veld, which I have analysed in a recently published paper. The dominant species are usually Acacias. Under the Kaap plateau, along the right bank of the Orange and the Vaal, there is fairly dense Acacia scrub, with the Haakdoorn *Acacia detinens* dominant. Further north in the Vryburg district, east of Höning Vlei, and north-west of Morokwen, there are large areas of Haakdoorn Scrub of a similar nature. From Fourteen Streams northwards through Taungs and Bloemhof, the dominant plant is the Vaal bosch, *Tarchonanthus camphoratus*. Further to the west, through Kuruman, the following trees are dominant in the Tree Veld or Bush Veld:—*Acacia giraffae, A. karroo, A. horrida, A. robusta, A. spirocarpoides, A. haematoxylon, Zizyphus mucronata, Elephantorhiza burchellii, Rhus spp., Royena pallens*, etc. Further north in Bechuanaland the tree species are *Acacia giraffae, Combretum primigenium, Boscia pechueli, B. microphylla*, etc. In the northern Kalahari, the Tree Veld is still more tropical in its nature, with *Copaifera mopane, Adansonia digitata, Peltophorum africanum, Strychnos sp.*, etc.

4.—THE KARROO AND KARROID CENTRAL REGION.

This region has a dry continental type of climate, the average rainfall for different parts varying between 3 and 14 inches. On the south western side it is bounded by the region of Macchia already described. On the east, it grades into Grassveld, the approximate boundaries of which are given later, when the transitional belt between the two is dealt with. On the north, it grades into Sand Veld, the boundary being a wide curve from Hopetown to Prieska, and thence southward to Carnarvon. Still further west through Kenhart, Calvinia, and Bushmanland, there are many areas of Karroo, but the whole of this area must be considered transitional to the desert types of the west, much of it consisting of red sandy flats and sand hills. In this western transitional area, one of the most important grasses is the Vogelstruis or Ostrich grass, *Eragrostis spinosa*. Drège describes it as covering vast tracts, and Burchell in his "Travels" (1810-15) refers to it as follows. The quotation is worth giving at length. "I now" (at the Little Thorn River) "gathered for the first time specimens of a very extraordinary grass. Its panicle of flowers formed a bunch of strong sharp thorns, so rigid and pungent that no animal could graze near it, nor would the naked legged Hottentots venture to walk among it, although it was not more than a foot and a half high." The Toa grass, *Aristida brevifolia*, may also be described as covering vast tracts in the same region. It is a suffrutescent species. Other species of Aristida (*A. obtusa*, *A. vestita*, *A. ciliata*, *A. uniplumis*, *A. namaquensis*) are also common, and show the close connection with the Western region. *Stipa tortilis* is another characteristic species.

In the Karroo proper, the dominant vegetation is of a succulent and sclerophyllous dwarf shrub type, made up of Crassulaceae, Aizoaceae (*Mesembrianthemum*), Compositae, and many other orders. The Compositae increase in importance towards the north. *Pentzia virgata* (Karroo bush) is dominant over wide stretches.

As far as the actual number of species is concerned, the grasses are fairly well represented, but very few of them can be considered as specially of a Karroo type, and they are of comparatively little importance in the climax stages of the succession on the typical Karroo flats. They are confined for the most part to the dongas or ravines, and stream beds, or

the shallow moist depressions known as "laagtes." Surface water may not be present, in fact it rarely is, but nevertheless the habitat is more mesophytic than elsewhere in the region. After rains, they tend to spread very quickly, forming part of the "opslag" type of vegetation, and during the long spells of drought they retreat to the moister centres of distribution. The Kweek gras, *Cynodon incompletus*, is one that behaves like this.

The two most important genera in the Karroo are *Aristida* and *Eragrostis*, as they are also in the initial stages of grassland succession on the whole of the eastern side of South Africa. The species of *Aristida* are *A. adscensionis*, *A. bipartita*, *A. congesta*, *A. barbicollis*, *A. vestita*, *A. ciliata*, *A. obtusa*, *A. uniplumis*; and of *Eragrostis*, *E. curvula*, *E. chloromelas*, *E. porosa*, *E. bicolor*, *E. procumbens*, *E. brizoides*, *E. bergiana*, *E. obtusa*.

Sporobolus is another pioneer genus as a rule, and in the Karroo region it is represented by *S. ioclados*, *S. tenellus*, *S. ludwigii*, *S. fimbriatus*, *S. indicus*.

Other Karroo species include *Tragus koelerioides*, *T. racemosus*, *Crossotropis grandiglumis*, *Oropetium capense*, *Enneapogon scaber*, *E. scoparius*, *E. mollis*, *E. brachystachyus*, *Schismus fasciculatus*, *S. aristulatus*, *Tetrachne dregei*, *Pentaschistis angustifolia*, *Achneria setifolia*, *Ehrharta erecta*, *E. calycina*, *Avenastrum turgidulum*, *A. antarticum*, *Fingerhuthia africana*, *F. sesleriaeformis*.

A number of more typical Eastern species are also fairly frequent in the moister situations mentioned, e.g., *Rottboellia compressa* var. *fasciculata*, *Elionurus argenteus*, *Andropogon nardus* var. *marginatus*, *A. hirtus*, *A. contortus*, *Anthistiria imberbis*, *Paspalum scrobiculatum*, *Digitaria eriantha*, *Panicum serratum*, *P. deustum*, *P. maximum*, *P. minus*, *Axonopus semialatus* var. *ecklonii*, *Tricholaena setifolia*, *T. rosea*, *Koeleria cristata*, *Chloris virgata*, *Ch. petraea*. *Stipa dregeana* and *Eragrostis lehmanniana* occur only in the shade of the stream-bank Bush.

The following are hygrophilous and belong to the hydrosere, *Erianthus capensis*, *Andropogon dregeanus*, *Setaria lindenbergiana*, *S. aurea*, *S. flabellata*, *Pennisetum macrourum*, *P. thunbergii*, *Arundinella ecklonii*, *Phragmites communis*, *Polypogon monspeliensis*, *Agrostis lachnantha*.

The following are ruderal species: *Digitaria sanguinalis*, *Panicum crus-galli*, *Setaria verticillata*, *Cynodon dactylon*, *Phalaris minor*, *Eleusine indica*, *Bromus commutatus*, *B. patulus*, *Brachypodium distachyum*, *Lolium multiflorum*, *Eragrostis major*.

In the mountain ranges of the Karroo region—the Roggeveld, Komsberg, Nieuwveld, and Sneeuwberg, most of the species enumerated above occur, but at altitudes of 4,000-8,000 feet, there are considerable differences in the environmental factors, and a number of other interesting species are found. The Roggeveld are said by Thunberg to have been so named from the wild rye grass, *Secale africanum*, but it does not seem to be common. It is unfortunate that all those great ranges have not been better explored botanically.

It has already been pointed out that the South Western species, or nearly allied species, belonging to the same temperate tribes, tend to spread eastward along them. *Danthonia* is represented by *D. stricta*, *D. purpurea*, *D. cincta*, *D. disticha*. There are two or three species of *Achneria* (*A. setifolia*, *A. microphylla*, *A. hirsuta*). *Pentachistis* has *P. angustifolia* var. *cirrhulosa*, *P. densifolia*, *P. acroides*. The genus *Melica*, of the tribe Festuceae, is peculiarly characteristic of this region. There are half-a-dozen species, *M. racemosa*, *M. bolusii*, *M. ovalis*, *M. decumbens*, *M. pumila*, *M. neesii*.

Other mountain species include the bok-baard, *Festuca caprina* (a useful pasture plant), *F. scabra*, *Anthoxanthum ecklonii*, *Tetrachne dregei*, *Fingerhuthia africana*, *Microchloa caffra*, *Harpechloa capensis*, *Koeleria cristata*, *Andropogon hirtus*, *Anthistiria imberbis*.

THE TRANSITIONAL BELT BETWEEN KARROO AND EASTERN GRASSVELD.

This belt is of particular interest because it gives us an opportunity of studying the establishment of definite Grassveld, of the type which extends over the whole eastern side of South Africa. It is very difficult to draw any definite boundary line between Karroo and Grassveld, since everywhere in the transitional belt there are patches of Karroo and Composite Veld interspersed with grassland, or towards the west it is better to say that patches of grassland are interspersed with Karroo. Further, owing to the effects of overstocking, the grasses are often eaten out, the surface layers of

soil are hardened, there is a greater run-off of water, and numerous dongas and ravines appear along the sheep or cattle tracks, and the water table is lowered. The surface layers become drier and hard baked, and Karroo conditions are established. There seems to be no doubt that the Karroo has extended rapidly eastward within recent years, and parts of the transitional belt have become intersected by dongas to an extraordinary degree. Over considerable areas around Tarkastad, there is very little soil left. Such considerations make the study of the plant succession of vital importance from the agricultural or economic standpoint.

On the coast belt from Port Elizabeth northwards through the Alexandria and Albany divisions, there is much grassland, but there is also a great development of succulent and thorny Scrub (Fish River Scrub, Addo Bush, etc.). In this region, too, the eastern boundaries of the S. Western Macchia are reached. From Alicedale northwards to Cookhouse the railway line lies parallel and close to the eastern boundary of Grassveld. From Cookhouse the Karroo extends somewhat irregularly to a point east of Tarkastad, and from there the boundary line more or less follows the mountain ranges. At Steynsburg it is fairly sharply defined, but farther north the Karroo has an eastward extension towards Aliwal North. North of the Orange River in the Free State, it is very difficult within wide limits to draw any boundary line. If the southern Free State is visited after a long spell of dry weather, one would be inclined to classify it all as Karroid. After good rains, on the other hand, the grass grows quickly, and open Grassland developes, dominated chiefly by *Eragrostis*, *Aristida*, and *Enneapogon*. At Hopetown we reach the southern boundary of the Sand Veld region.

The hydrosere in this region need not be dealt with at length, since it is essentially the same as for the Karroo itself, with a few extra species belonging to the Eastern Grassveld region. The ruderal species are also of the usual widespread types.

In the early stages of the xerosere a number of species form consocies. *Cynodon incompletus* (Kweek gras) is one of the most widespread and important. It often forms an almost pure growth over bare, dry slopes. Its prostrate creeping stems, which root at the nodes, enable it to extend rapidly after rains, and it is quickly followed by other species, which gradually take its place, especially species of *Eragrostis* (*e g.*,

E. chloromelas, *E. obtusa*, *E micrantha*, *E. chalcantha*, *E. curvula*), species of *Aristida* (*A. congesta*, *A. vestita*, *A. adscensionis*), and species of *Sporobolus*, some of them characteristic of, or confined to this region (*e.g.*, *S. albicans*, *S. tenellus*, *S. discosporus*, *S. ludwigii*, *S. ioclados*, *S. indicus*). *Cynodon* itself is usually reckoned a good grazing grass, though sometimes viewed with suspicion as being possibly the cause of lamziekte in stock, especially during spells of drought.

The species of *Aristida* are wiry and not nutritious and *Eragrostis* species, though a few of them are good, are also, as a rule, of little worth. Grassveld, therefore, at its very earliest stages, is looked upon as of good grazing quality, while the immediately succeeding stages may be poorer. The Aristida-Eragrostis-Sporobolus associes, however, if the succession is not kept back by grass burning, slowly passes into Anthistiria-Andropogon Veld, which is the climax stage for the most part in Eastern Grassveld. Further details of the succession will be described later, but here it may be pointed out that it is particularly desirable, especially in drier regions such as this transitional belt, to refrain from burning the grass or from overstocking, or from any of the common means of interfering with the proper succession since the climax stage is the one which it is most desirable that the Grassveld should reach, where the Red grass (*Anthistiria imberbis*), one of the best grazing grasses, is dominant. Further, the earlier Erogrostis-Aristida associes should not be burned, because being deep rooted species they help to bind the soil, and prevent soil erosion, in addition to preparing suitable conditions for the spread of *Anthistiria*, which is unable to colonise bare areas by itself.

The above sere of which the three stages are (1) Cynodon, (2) Eragrostis-Aristida-Sporobolus, (3) Anthistiria-Andropogon, may be taken as typical of the whole area, but there are many local variations. The Cynodon stage is often omitted. Practically all the species of *Eragrostis*, *Aristida*, and *Sporobolus* are capable of acting as pioneers, and the innumerable colonies or socies of one or other of the numerous species named above, or of those named as characteristic of the Karroo region—for they nearly all occur in the transitional belt—makes this open type of Veld appear at first sight extremely confusing. Not only so, but the list of species, which act as pioneers, is by no means exhausted. *Oropetium*

capense, a dwarf grass, forms consocies in the dry Veld around Sterkstroom and elsewhere. *Crossotropis grandiglumis* is very common, but usually only forms small colonies with other species. *Tricholaena setifolia* is fairly common. *Tragus koelerioides* and *T. racemosus* are both characteristic of stony hillsides in the region. The genus *Enneapogon* is peculiarly characteristic of the region. The species *E. scaber* and *E. mollis* are most widespread, *E. scoparius* and *E. brachystachyus* more local. Enneapogon-Eragrostis associes. cover great areas, as already mentioned, in the Southern Free State, all the Veld being of a primitive type.

Little need be said regarding Anthistiria-Andropogon Veld in the transitional belt, for it is essentially the same as Eastern Grassveld, which will be described more fully later.

Haas-gras Veld. This is another "substituted" type which is of peculiar interest for many different reasons. For many miles around Molteno, Anthistiria Veld has practically entirely disappeared, and the Haas-gras (*Danthonia purpurea*) has become completely dominant. It is a low-growing species, scarcely more than an inch or two high (see Fig. 9). The margins of its leaves are long ciliated, and this gives it the appearance of being extremely xerophytic. As a matter of fact, it is drought resisting, and also frost resisting, and it gives good grazing, when other grasses are withered. Its leaves are small but somewhat succulent, and packed full of starch to an extent which is never reached by the larger leaved sub-tropical eastern types (see Fig. 10). Sheep are fond of it, and it is generally looked upon as a good grass. For further details see under *Danthonia* in Part III.

The plant succession in the Haas-gras Veld is as follows: *Cynodon incompletus* is everywhere, so far as I have been able to explore the area, the chief pioneer. Eragrostis-Aristida associes or separate Aristida and Eragrostis consocies usually follow, or sometimes these form the initial stages themselves. The climax consists of a Danthonia consociation, with societies of *Microchloa caffra*, *Tetrachne dregei*, *Eragrostis micrantha*, *E. chalcantha*, *Aristida vestita*, and occasionally *Anthistiria imberbis*. I have only been able to visit the Molteno district in autumn, and there are probably other vernal aspect societies. The type would certainly repay further investigation.

The historical evidence seems to prove that the *Danthonia* has replaced Anthistiria Veld within recent times, but at

present the soil, which is a hard-baked clay, with a little sand on the surface, is hardly the type which would support Anthistiria Veld.

The explanation of the change, which is here suggested, is as follows. When the district became opened up to the white settler, sheep and other stock were introduced, and the Veld grasses were regularly burnt. *Anthistiria* is a species with its innovation buds intravaginal, and it does not stand burning well. If the burning is done early, it is not alllowed to seed, and, even if it were, the seeds seem to prefer to germinate in the shade of dead herbage, through which the seedlings may be seen to make their way. *Anthistiria* rarely colonizes bare areas. Stock prefer it to most other grasses, and it tends to be eaten out. Its gradual disappearance is a common phenomenon on farms throughout the Eastern Grassveld region. Usually, however, it is replaced by initial stages of the sere, chiefly worthless Aristidas, and not by a succulent dwarf type like *Danthonia*, which, it may be recalled, is also eaten by sheep. We have not, however, exhausted the factors. The constant tramping of the soil by stock, when allowed to wander to and fro at will, has a much greater effect on the soil than is generally realized. The surface few inches are hardened, and the rainwater, instead of soaking in, tends to run off. Sheep tracks and cattle tracks serve as surface drains, and these are very quickly deepened into dongas. The result of it is that the whole of the soil is dried out by the system of intersecting dongas, and only xerophytic grasses are able to survive. It is a fortunate thing that a grass can sometimes be xerophytic, and at the same time fairly nutritious, as is the case with *Danthonia purpurea*, but it is very restricted in its distribution, and its place is often, in fact usually, taken by Aristidas or *Eragrostis* species, most of which are very poor fodder grasses. The soil over which *Danthonia* is dominant appears as dry as most Karroo soils, and another economic aspect of the study appears worth investigating, namely, whether *Danthonia purpurea* would survive under Karroo conditions, and if so whether it would prove a better food for stock than the shrubs at present dominant there. It may be recalled that *Danthonia penicillata* and *D. robusta*, according to Maiden, are two of the best fodder grasses in Australia.

One other point of purely scientific interest is the fact that *Danthonia purpurea*, which has thus conquered for itself a place in Eastern Grassveld, and ousted the sub-tropical

species like *Anthistiria*, is a temperate type, with all its affinities in the South Western floral region. It is an endemic species with a very restricted distribution, and if we accept Willis's "Age and Area Law" it would appear to be a new type or recent mutation. It extends from the Stormberg district westward along the mountain ranges as far as the Nieuwveld.

The mountain grasses and grasslands of the transitional belt (*i.e.*, of the Stormberg and neighbouring ranges) show connections with the ranges further west, and also show the establishment of the types of mountain grassland, which extend right along the Drakensberg.

The species which show Western affinities include most of those already mentioned for the mountains of the Karroo region. The genus *Melica* is much in evidence. *M. racemosa*, which extends from the Cape to Natal, is one of the commonest species. *M. ovalis* and *M. decumbens* (Dronk-gras) are also characteristic. *Danthonia disticha* grows in large isolated wiry tufts on rock slopes. *D. cincta* and *D. macowani* are also found. *Pentaschistis curvifolia*, *P. fibrosa*, and *P. longipes* are not common.

Other temperate species include *Achneria setifolia*, *A. microphylla*, *A. hirsuta*, *Ehrharta calycina*, *E. erecta*, *Avenastrum turgidulum*, *A. antarticum*, *A. caffrum*. All the above grow among the shrubs, which clothe the rocky mountain slopes, and hardly form definite grassland. There is a good deal of Leucosidea Scrub in this region, a type which assumes great ecological importance along the Drakensberg.

There is, however, a certain amount of definite Mountain Tussock Veld established, similar to that of Natal, which will be dealt with fully later. *Microchloa caffra*, *Festuca caprina*, *F. costata*, *F. longipes*, *F. scabra*, *Anthoxanthum ecklonii*, *Koeleria cristata*, *Sporobolus centrifugus* all enter into the composition of it, forming hard tussocks. In the moister situations, the Tussock Veld grades into Scrub, the transition being shown by the development of taller grasses, *e.g.*, *Arundinella ecklonii*, *Andropogon appendiculatus*, *A. auctus*, *A. dregeanus*, *A. plurinodis*, *Erianthus sorghum*, *E. capensis*, a type of succession exactly similar to that of all the great forest areas of the Eastern region.

5.—EASTERN GRASSVELD REGION.

This great region of summer rainfall comprises the whole eastern side of South Africa. The dry season coincides with the season of lower temperatures, and the Veld vegetation, therefore, has a well-marked resting period, when all the herbage withers. Renewed growth begins with the first rains in Spring. In its larger aspects, the climate of the whole region is, therefore, a uniform one, and in taking a broad general view, there is no reason why the whole of the Eastern Grassveld should not be considered one formation, determined by the summer rainfall. A closer analysis, however, at once reveals the fact that there are very distinct climatic variations throughout the region. The most general of these is the variation in the *amount* of rainfall. The rain-bearing winds come in from the Indian Ocean, and deposition takes place, chiefly on the rising slopes which face east or south-east. Other aspects, as well as the great river valleys, remain relatively dry. We thus get a fairly well-marked division into High Veld and Low Veld or Valley types. Not only do the climates differ in these two cases, but the soil conditions do so also. The High Veld soils are looser, moister, and better aerated, though usually poorer from the agricultural standpoint. The Low Veld soils are drier, harder, more clayey, but richer in chemical salts. In spite of the considerable differences, both climatic and edaphic, between the two habitats there is not the difference in the composition of the grass veld, which one would naturally expect. Though there are distinctive Low Veld and High Veld species, yet a large number occur in both, the differences, if any, being merely varietal. There are, however, easily recognisable differences in the general physiognomy of the two types. The High Veld grasses are, as a rule, taller, the Low Veld grasses lower growing, and the difference in colour is reflected in the names Red grass for High Veld and Blue grass for Low Veld. As a matter of fact, the dominant Blue grass is simply a glaucous variety of *Anthistiria imberbis* (the "Red grass"), though sometimes glaucous varieties of *Andropogon hirtus*, which is often dominant in Low Veld, are also called Blue grass.

There are other climatic variations in the region, which lead to the establishment of types, which are very distinct, both in physiognomy and in composition. These, undoubtedly, must be considered distinct formations. The most important is the Tussock Grassveld of the Drakensberg, where the

factors of temperature, light and moisture all differ. The Grassveld of the coast belt, especially towards the north in Natal and Zululand, is also under different climatic conditions, owing to the relatively high temperatures and absence of frosts. Tropical species are common, and there are a great many (*e.g.*, species of *Panicum*), which do not occur elsewhere in South Africa. The coast grassland should, however, perhaps not ranks as a formation, for I doubt whether any of it possesses the necessary degree of stability. The climax type for the whole belt seems to be Bush, and the Grassveld, if left alone rapidly progresses into Bush. As a matter of fact, much of the High Veld is also transitional to Bush or Forest.

It would be impossible, within the limit of the present work, to deal in detail with all the different varieties of Grassveld in the Eastern region, even if all the facts were known. What is to be aimed at, is the analysis of the more important types of succession. These have been studied and tested fairly thoroughly over the whole of Natal, and to a certain extent over parts of the Free State and the Transvaal, but, of course, a tremendous amount of work remains to be done. Many districts, *e.g.*, the whole of Pondoland and most of Zululand, are difficult of access, and remain, to a large extent, unexplored.

The successional relationships of the grasslands to other types of vegetation are as important as the various seres in the grassland itself. The most important among the former are the transitions to Forest, which are seen in many parts of the High Veld and Coast Veld of Natal, and Eastern Cape Colony, and the transition to Thorny Scrub through various stages of open Thorn Veld, a detailed account of which I have given in the paper already referred to.

In the following description of Eastern Grassveld, a general account of the xerosere will first of all be given, which will conclude with a description of climax types and aspect societies and the transition to Forest. Afterwards the hydrosere and various sub-seres will be dealt with. The mountain grasses of the Drakensberg and Mountain or Tussock grassland as well as the coast belt of Natal will be considered separately.

The Xerosere.

The early stages can only be dealt with very briefly. They vary greatly in different localities, and any of the types

would form a most interesting subject for detailed study. Each stage has a certain degree of stability of its own, and each is being constantly repeated in the initial stages of various sub-seres. They may be classified as follows:—

(a) *Lichen Colonies.* These colonize bare rock surface and consist of crustaceous and foliose types. Over the whole of the Eastern side, though examples are abundant, there is no extensive lichen development as there is on the Western side. The Lichens are a group which have been very little studied in South Africa.

(b) *Cyanophyceae Colonies.* These are very extensively developed, especially at higher altitudes, and consist of species of *Schizothrix*, *Stigonema*, *Glococapsa*, *Calothrix*, *etc.*, which form black coverings over damp rock surfaces.

(c) *Colonies of Mosses and Hepatics.* This type has recently been dealt with by Sim[1]. Mosses and Hepatics are of considerable importance in preparing a seed bed for higher plants which soon follow.

(d) *Lithophilous Colonies of Ferns and Flowering plants.* It is impossible to give anything approaching an exhaustive account of these. They are far too numerous and varied. The following are a few common examples:—

(1) *Selaginella rupestris* often forms loose mats over rocks which are periodically wet, but which often remain dry for months, when the mat becomes dry and shrivelled. A loose shallow soil gathers underneath.

(2) *Cyperus rupestris* grows over soil, which is an inch or so deep, and wet. The *Selaginella* and *Cyperus* often mix.

(3) Other Cyperaceae, such as species of *Bulbostylis* (*B. collina*, *B. striatella*) or *Fimbristylis*, also form pioneer colonies on rocks.

(4) *Crassula* colonies are numerous and widespread.

(5) *Mesembrianthemum* colonies.

(6) *Cyanotis nodiflora*, a very frequent pioneer on rocks; loose and straggling in its growth. Such species rarely form pure growths. They are quickly followed by numerous others, *e.g.*, species of *Oxalis*, *Hypoxis*, and other small bulbous or tuberous forms. The pioneer grasses are usually very early arrivals.

1. Sim, T. R. "The Geographical distribution of Bryophyta in S. Africa." *S. A. Journal of Science*, 1918.

(e) *Chomophyte or Crevice Successions.* Rock crevices and rock ledges provide shelter and a suitable germinating ground for a great assemblage of species. Soil gathers and may be deep, and there are all degrees of variation in the amount of moisture and shade. Wind-blown seeds are blown into rock crevices, and birds, which carry seeds, find there is a natural sheltering place. It is not surprising, therefore, that it is possible to find nearly the whole flora of a district represented in such situations. The crevice succession may lead up to grassland or more frequently and, at least temporarily, to rocky Scrub. In the Veld succession the crevices become obliterated by the accumulation of soil. Definite grassland demands a certain smoothness of surface, and on steeper hillsides or broken ground of any sort there remain numerous clans or societies of various different species which careful examination will show belong to a Chomophyte stage in the plant succession. There are, of course, other species which mix more intimately with the grasses and usually form distinct aspect societies.

Initial Grassland Stages. Pioneer Grasses.

There are numerous ruderal grasses, some of them useful for grazing, which form the initial grassland stages in various sub-seres, which will be dealt with later. Ruderal or annual species do not play any important part in the prisere, though they are often present. The chief pioneer grasses are all xerophytic, deep rooted, light demanding species. It is interesting to notice that the seeds of many of them (*e.g.*, *Aristida* spp) are capable of boring their way down through quite hard soil. Their seedlings require little or no shade or shelter in the earlier stages. They grow in spreading caespitose tufts, and do not form a close covering over the soil surface. Their renewal buds are usually extravaginal, and buried in the soil, some of them being slightly stoloniferous. They are not much injured by fire.

In a few cases (*Cynodon*) they are creeping forms, which root at the nodes, but this type is exceptional. Owing to their xerophytic nature, and the amount of hard sclerenchyma in their leaves, they are not liked by cattle, and many of them, especially the Aristidas, are only eaten in Spring, when the young and softer leaves are produced. Nevertheless, some of them, especially the species of *Eragrostis*, are fairly nutritious grasses. *Cynodon* is considered quite a good grass, and stock are fond of it. It is interesting to notice the close simi-

larity between the initial stages of Eastern grassland, and the climax stages in the Western and Karroo regions, and in the transitional belt. The genera, which we have seen are characteristic of those regions, are also the genera most prominent in the establishment of Eastern Grassland and many of the species are identical. *Aristida*, *Eragrostis* and *Sporobolus* are all important, and it is difficult to decide which of the first two should take precedence.

Aristida junciformis is the chief pioneer over considerable portions of the midlands of Natal, mostly in High Veld. The very similar *A. angustata* is more prominent in similar situations in the northern portion of Natal and the Transvaal. *A. barbicollis* is widespread, and occurs in both High Veld and Low Veld. The nearly allied *A. congesta* (Steek gras) is dominant over immense stretches of primitive Veld in the Free State, and is common also in Natal and the Transvaal. *A. bipartita* in Natal prefers the Low Veld, but it is by no means rare in the High Veld and Mountain Veld. *A. adscensionis* and *A. vestita* are more Western types, and are rare in Eastern Grassveld. The Zulu name *umGongoni* seems to be applied to different kinds of Aristida, but particularly to *A. barbicollis* and *A. junciformis*. For further details see under *Aristida* in Part III. Most of the Aristidas, with the exception of *A. bipartita*, flower late.

Eragrostis chloromelas forms vernal aspect socies in the primitive veld over the whole region. *E. curvula* (umrrepurrepu) is another early flowering species, very important in the initial stages of veld development. The variety *conferta* covers wide stretches in the High Veld. It is very common in spring along the railway enclosures, forming large waving tufts. *E. chalcantha* is the chief pioneer in much of the Transvaal High Veld, and in both High and Low Veld in Natal. It flowers early. *E. brizoides* is also sometimes a pioneer, but it tends to linger through the climax stages.

E. micrantha and *E. atherstonei* are smaller species, common in bare rocky areas, but they do not assume dominance at any stage. *E. plana* (umTshiki) forms autumnal aspect socies or is completely dominant over wide stretches of primitive veld, usually High Veld or "mixed" Veld. *E. plana* and *Sporobolus indicus* form very definite and very extensive associes. *E. heteromera*, a species very slightly different from *E. plana*, appears to be fairly widespread also.

There are many other species of *Eragrostis*, some of them ruderal, some belonging to the hydrosere, and some to the climax stages of Veld.

Sporobolus indicus (umSingisan) is the chief species of this genus; dominant over large areas of primitive veld; often mixed with *E. plana*, sometimes with *Andropogon hirtus*. *S. festivus* var. *stuppeus* is an interesting tussock-forming pioneer. *S. fimbriatus* is more Western and *S. rehmanni* more tropical (Natal coast belt).

In addition to the various species of *Aristida*, *Eragrostis* and *Sporobolus*, there are a number of others, which belong to the initial stages of the sere. The two Cynodons or Kweek grasses, *C. incompletus* and *C. dactylon*, with several varieties, both colonize bare surface, but on the whole are more important in sub-seres, occurring along roadways or in cattle kraals where the Veld has been manured, or on Termites' nests. *Crossotropis grandiglumis*, *Tragus racemosus*, *Tricholaena setifolia*, *Diplachne biflora*, *Chloris petraea* are all characteristic of the open Veld of rocky hillsides.

Usually in the primitive stages, there is a greater or less admixture of the species dealt with below, which are more characteristic of the climax stages. *Andropogon hirtus*, though it is dominant over much stable Veld, also acts as a pioneer. *A. schoenanthus* var. *versicolor* is similar, and there are many others. In order to avoid confusion, such mixed types are not dealt with at length. Wherever the various species of *Aristida*, *Eragrostis* or *Sporobolus* mentioned above are found to be dominant, it may be taken for granted that the Veld is at a relatively primitive stage of development, and, for farmers, the question of how it should be treated is the one which is of greatest interest. It has already been pointed out that the grasses are deep rooted, xerophytic, hard, and wiry, and farmers are usually very positive that they must burn to get young shoots, or otherwise cattle will not eat the grasses. This is true, but it should be clearly recognised that the burning has two further effects, namely, it prevents the succession from going any further, and causes the Veld to remain of a primitive type, and, secondly, it increases soil erosion by laying bare the surface, at the very time when the heaviest rains fall. Of course, it is not to be denied that some of the pioneer grasses, provided the cattle can be induced to eat them, are not without value, in fact, some of them are quite good (*e.g.*, several species of

Eragrostis), and it is for each farmer to decide whether it is worth his while to leave the grass unburnt so as to give it a chance to progress towards the *Anthistiria* stage of the succession, which is undoubtedly of a superior type, and at the same time to lessen soil erosion, or to continue to make use of the harder grasses, by continually burning them to obtain young shoots.

Stable grassland. Climax stages.

In the subsequent stages of development a large number of species take part, the majority belonging to the tribe Andropogoneae, which includes *Anthistiria imberbis* (inSinde or Red Grass), the species which is usually dominant. When we compare these subsequent species with the pioneers, we notice many points of difference. The chief characters of the latter have already been considered. The former are not so xerophytic, nor so deep rooted. They form a closer mat over the surface of the soil, and thus prevent the run-off of water to a large extent. Their shallow spreading root systems obtain moisture first, before it is able to soak down to the lower levels, and this is partly why they are able to oust the pioneers. Light, however, is another factor of considerable importance. The seedlings of *Anthistiria*, for instance, prefer to germinate in the shade of other herbage. It is particularly interesting to notice in mixed transitional grassland, how young plants of *Anthistiria* almost invariably come up through the middle of a tuft of *Aristida*, which gradually becomes smothered as the *Anthistiria* grows taller and shades it, and also forms a mass of roots immediately above those of *Aristida*. *Aristida* seedlings themselves, on the other hand, do not seem to tolerate shade. They usually germinate in the open spaces. The pioneer species therefore prepare the way—and it is a necessary preparation—for the establishment of the climax types.

Over by far the largest areas of Eastern grassland *Anthistiria imberbis* (inSinde) is the dominant species. It covers enormous areas in the Eastern Province of the Cape, Natal, the Northern and Eastern Free State, and the Transvaal. There are several varieties, which are not always easy to distinguish. A closer study of the species would repay attention, and ought to be undertaken. Stapf has distinguished three varieties, *viz.*, *mollicoma* with leaves and involucral spikelets densely hairy, *argentea* with leaves densely hairy, but involucral spikelets glabrous or scantily hairy, and *burchellii* with

laxer panicles and longer spathes, but there are certainly many intermediate varieties, and the different extremes may be found growing together. Though I have given a good deal of attention to the species, at present I prefer not to record any observations on the distribution of the separate varieties. The peculiar glaucous tint in the leaves of the Low Veld variety has already been referred to. *Anthistiria* is the chief pasture grass in South Africa, and it makes a good hay. Its innovation buds are intravaginal, and it is consequently easily burnt out. Its dead leaves tend to break up into fibres which form a spongy mat over the surface of the soil, thereby retaining water, and lessening soil erosion. As already mentioned, it is not so deep rooted as the species which precede it.

Anthistiria is associated regionally with numerous other species, some of which form consociations, and a much larger number societies, while many remain somewhat sparsely mixed with the dominant species. Anthistiria-Andropogon associations are the commonest, in fact the whole formation is practically made up of them. *Andropogon hirtus* occurs abundantly in the High Veld, and forms large consociations chiefly in the Low Veld. *Andropogon schoenanthus* var. *versicolor* is sometimes associated with it, but is not quite so important. *Andropogon nardus* var. *marginatus* forms societies (more rarely consociations) in the High Veld and in the Low Veld. *Andropogon ceresiaeformis* is practically confined to the High Veld, sometimes forming pure consociations, but more often occurring as a sub-dominant species in *Anthistiria* Veld. The following species of *Andropogon* are more sparsely scattered: *A. schirensis* var. *angustifolius*, *A. amplectens*, *A. eucomus*, *A. hirtiflorus*, *A. filifolius*, *A. distachyus*, *A. pertusus*, *A. intermedius* var. *punctatus*. *Andropogon contortus* is an early flowering species which forms vernal aspect societies. All the other Andropogon species (which are included in the sub-genus *Cymbopogon*) belong to a further stage in the development being transitional to Forest or else they belong to the hydrosere, since in both cases they require moister conditions than are found in typical Veld.

Elionurus argenteus is a widely distributed species which forms consociations in much of the Eastern Grassveld. In Natal these are widely scattered, but not individually extensive. In the Transvaal from Wonderboom Poort to the Crocodile River they become one of the dominant types. *Trachypogon polymorphus* var. *capensis* is very common, but grows in isolated tufts or at most forms small clans. *Urelytrum*

Fig. 23.—*Eragrostis brizoides,* showing Vivipary. This condition was common in several kinds of grasses during the wet season of 1917. ($x\frac{1}{2}$).

squarrosum is similar. *Pollinia villosa* is commonest in Coast Veld, and the other genera of the tribe Andropogoneae belong to the hydrosere.

The Paniceae are very poorly represented in the climax Grassveld, the majority of them being ruderal or belonging to the forest sere, but a few are of importance. The large genus Panicum is represented by *P. serratum* and *P. natalense*. *Digitaria monodactyla*, *D. eriantha*, *D. setifolia*, *D. diagonalis*, *D. tricholaenoides* all enter more or less into Grassveld. *Axonopus semialatus* var. *ecklonii* is common in early spring and forms small societies. The Tricholaenas belong to the early stages, and *Setaria perennis* is the only common Veld species of *Setaria*, the rest belonging to the hydrosere.

Trichopteryx simplex is common and forms clans; the other species *T. flavida* and *T. dregeana* are not so common. *Tristachya leucothrix* forms vernal aspect societies. *T. rehmanni* is a Transvaal species fairly common in the High Veld. The great tribe of the Aveneae are hardly represented, though so abundant in the South Western region. *Koeleria cristata* and *Avenastrum turgidulum* occur, but are rather to be reckoned as Mountain Veld species.

Among the Eragrosteae, the two species *Eragrostis gummiflua* and *Pogonarthria falcata* form an association, which is characteristic of the dolomite soils of the Transvaal. Both species occur more sparsely elsewhere. The majority of the species of *Eragrostis* are found in the initial stages, but some occur in the climax grassland, *e.g.*, *E. brizoides*, *E. superba*, *E. lappula*, *E. caesia*, *E. denudata*. *Chloris virgata* is the only species of this genus which occurs in climax grassveld. The others are either ruderal or belong to the initial stages. All are reckoned very nutritious grasses. *Harpechloa capensis* is not common except at the higher altitudes. *Ctenium concinnum* is locally abundant (in Pondoland). The *Festuceae* and other smaller tribes are hardly represented except in Mountain Veld.

From the floristic standpoint, the almost complete absence of the temperate tribes Aveneae, Phalarideae, Festuceae, which include all the important Cape genera, is worthy of note.

The effect of continual grass burning on this climax Grassveld is very marked, and is seen throughout the whole region. The result is very simply expressed by the statement that burning sends back the succession, and causes the replacement of the climax stage by earlier or initial stages in the sere. "Substituted" types in this case are simply primitive types. *Aristida junciformis* (umgongoni) covers great areas of the Midlands of Natal, and many other Aristida consocies (*e.g. A. congesta*) in the Free State owe their origin to the same cause. The associes *Eragrostis plana-Sporobolus indicus* is another widespread type of the same nature. *Eragrostis curvula*, too, forms consocies, especially along footpaths, and the railway lines. As was noted for the Rhenosterveld of the S. West, such types have a certain degree of stability and only slowly return to the climax stages, if the causes which brought them into existence are removed, and if soil changes have not been too extreme.

Not only is burning of the grass a frequent cause of the change, but over-stocking is often of equal or even greater importance. The constant tramping of the soil, as has been already pointed out, has very pronounced effects, the immediate result being an increase of the run-off of water and increased erosion. The deepening dongas cause a general drying out of the soil, and once the changes are initiated the normal plant succession over great areas is rendered impossible. With the substitution of the Aristida types, burning becomes a necessity if the Veld is to be grazed, since cattle refuse to eat the older tufts of herbage. The whole question is of the greatest economic importance, and from the standpoint of practical farming is full of the greatest difficulties. This much may be said with certainty. Those parts of the Veld, which are still at the climax stage, should be carefully looked after, and nothing should be done which is likely to bring about the changes described. There are, however, other changes which take place in much of the High Veld, if the grasses are left unburnt, which involve the development of coarser, taller grasses representing a transition to Forest or Scrub, and if it is found desirable to pasture stock in such areas, then the grasses must be burned. This question will be discussed more fully later.

Aspect Societies and Clans in Eastern Grassveld.

As far as the grasses themselves are concerned, these have already been noted. In addition to the grasses, there are many

hundreds of common species of flowering plants in the Veld. Some of them are scattered as isolated individuals among the grasses, others form dense clumps. Several of them are known to be the cause of diseases in stock, and many others are under suspicion. The species vary considerably in different localities, and a very long or detailed account of them cannot be attempted here. Only common and widespread examples will be noted.

Prevernal Aspects. The grasses up to the end of August hardly commence growth, except in exceptional seasons, but a number of other species are in flower, even in mid-winter. *Gazania longiscapa*, *Gerbera kraussii*, and a few bulbous plants, *e.g.*, *Scilla lanceaefolia*, are examples. The prevernal aspect societies, however, are not conspicuous.

Vernal Aspects. These appear even before the first rains. Nearly all the species have underground storage of one kind or another. Bulbous monocotyledons occur in great numbers, but, among the numerous dicotyledonous orders represented, very few species can be found without either large tuberous roots or rhizomes or other means of underground storage. The drawing of *Helichrysum latifolium* (a common example), which is here reproduced (see Fig. 24), illustrates both rhizome and root storage. In some of the Asclepiadaceae, *e.g.*, *Raphionacme divaricata*, a very small aerial shoot may be found attached to a relatively huge underground tuber. In most cases, until the whole plant has been dug up, no idea can be formed as to the appearance of the true growth form. Nine-tenths or more of the total bulk of the plant may be underground. This fact should be emphasised, for it is not generally realised, and further it explains the fact, already mentioned, that growth commences in those types before the first rains. A sufficiency of water in addition to food is stored up in the tubers and bulbs to enable the plants to start growth, as soon as the temperature is sufficiently high. Temperature, then, is the chief factor responsible for starting growth in Spring. The importance of the temperature factor is also illustrated by the extraordinary and rapid development of Spring flowering plants over bare areas, from which the superficial layer of turf has been removed. The buried tubers, etc., are thus brought nearer to the surface, and are consequently more rapidly warmed by the sun's rays. Growth commences at once, and in a week or two the whole ground may be covered with flowers, though there has been

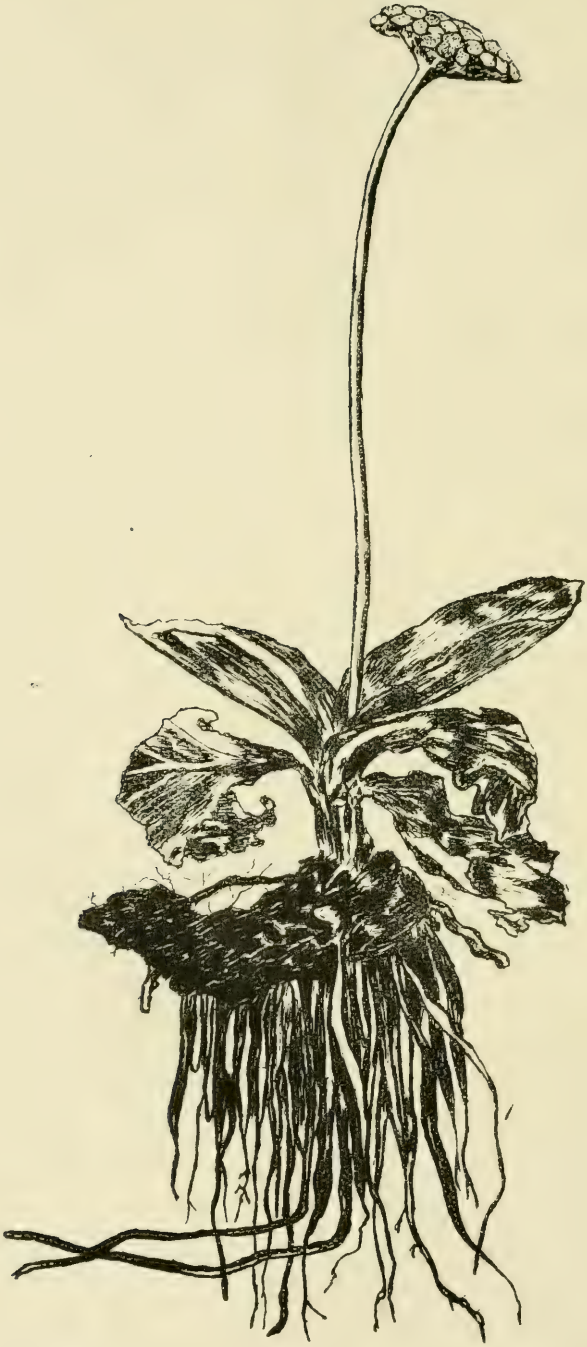

Fig. 24.—*Helichrysum latifolum* Less. A common spring flowering veld plan (x$\frac{1}{2}$).

no rain. A good example of this was seen in the grounds of the Natal University College last year, where a hockey field had been cleared of turf. The advantage of the early flowering lies in the plant being able to carry out the more important work of the year, before the taller growing aestival and autumnal aspects develop.

As for the species composing the vernal aspect societies, they are so numerous and varied in the different parts, that only a few of the commonest examples can be mentioned.

The Compositae are best represented. *Senecio latifolius*, a rather variable plant, is very abundant. *S. albanensis*, *S. bupleuroides*, *S. coronatus*, *S. erubescens*, *S. barbellatus*, *S. speciosus* (iBohlolo), and dozens of others occur in different parts. Over 70 species of Senecio are found in Natal alone. *Helichrysum* is another large genus. *H. latifolium*, *H. adenocarpum*, *H. squarrosum*, *H. aureonitens*, *H. foetidum*, *H. fulgidum* are all common, but altogether there are nearly 80 species, though a few of them are not Veld plants. The following are other common composites: *Gerbera kraussii* (uHlambiloshane), *G. aurantiaca*, *Vernonia hirsuta*, *V. kraussii*, *V. woodii* (uHlonyane), *Aster asper* (uDlutshana), *A. erigeroides* (isiThlelo), *Nidorella auriculata*, *Stoebe cinerea*, *Dicoma argyrophylla*, *Cineraria atriplicifolia*, *Callilepis laureola* (imPila), *Ethulia conyzoides* (umSokosoko), but the list might be extended to include two or three hundred.

The Leguminoseae are also very well represented, and interest attaches to them, since some of them are known to cause stock diseases. *Lotononis corymbosa*, *L. eriantha*, *L. foliosa*, *L. prostrata*, *Melolobium alpinum*, *M. obcordatum*, *Crotalaria burkeana*, *C. capensis*, *C. globifera*, *C. lanceolata*, *C. natalitia*, *Argyrolobium marginatum* (inTondo), *A. stipulaceum*, *A. uniflorum*, *A. longifolium*, *A. andrewsianum*, *A. rupestre*, *A. sutherlandi*, *Medicago denticulata*, *Indigofera dregeana*, *I. eriocarpa*, *I. dimidiata*, *I. fastigiata*, *I. hedyantha*, *I. hilaris*, *I. longipes*, *I. woodii*, *I. zeyheri*, *Eriosema salignum*, *E. kraussianum*, *E. cajanoides*, *E. longipes*, *Tephrosia capensis*, *T. longipes*, *T. diffusa*, *T. discolor*, *T. macropoda* (iLozane), *Lessertia biflora*, *Rhynchosia adenodes*, *R. totta*, *Vigna vexillata*, *V. triloba* are a few of the commonest species, and although the list seems a fairly long one it represents only a small proportion of the total.

The Geraniaceae are represented chiefly by species of *Pelargonium* (*P. aconitifolium* is the commonest) and a few Geraniums (*G. canescens*, *G. ornithopodum*) as well as *Monsonia attenuata*. Species of *Oxalis* are common, *e.g.*, *O. corniculata*, *O. pulchella*, *O. semiloba* (isiThathe or isiNungu), *O. convexula*. There is one species of *Rhus* (*Rh. discolor*) (Anacardiaceae). *Crassula* colonies are not frequent in the veld, being as a rule strictly pioneers. The Polygalaceae are represented by specis of *Polygala* (iThethe), *e.g.*, *P. hottentotta* and of *Muraltia* (*M. pilosa*), the Cruciferae by species of *Heliophila*, e.g., *H. linearis*, *H. virgata*. *Hypericum acthiopicum* (uSukumbhili), (Hypericineae) and *Psammotropha myriantha* (Aizoaceae) are both common in somewhat open Veld.

The Malvaceae have *Sida rhombifolia*, *S. cordifolia*, *S. triloba*, *Abutilon indicum*, *Hibiscus trionum*, and others, and the Sterculiaceae *Hermannia cristata*, *H. gerrardi*, *H. sandersoni*, *Mahernia grandistipula*, *M. auricoma*, *M. erodioides*, *M. parviflora*, and many more. *Tribulus terrestis* (Zygophyllaceae) is also common. The Umbelliferae include *Hydrocotyle asiatica*, *H. centella*, *Alepidea amatymbica*, *Bupleurum mundtii*, *Peucedanum capense*. The Rubiaceae are on the whole a Forest order, but certain genera belong to the Veld, including the species *Hedyotis amatymbica*, *H. decumbens* (uMampeshana), *Pentanisia variabilis* (iCimamlilo), *Spermacoce natalensis* (isiMuyisane), all very common. *Scabiosa columbaria* var. *dissecta* (Dipsaceae) is abundant. Among the Campanulaceae *Wahlenbergia undulata*, *W. zeyheri*, and other species are veld plants. A few of the species of *Lobelia*, *Cyphia* and *Lightfootia* sometimes occur. Species of *Erica* occur at the higher altitudes chiefly. Species of *Sebaea* (Gentianaceae) are common, *e.g.*, *S. crassulaefolia*, *S. sedoides*.

The Solanaceae are only represented by one or two Solanums, the majority of the species being ruderal. The Scrophulariaceae include a large number of veld species, but most of them do not belong to the vernal aspect societies, though some, *e.g.*, *Cycnium adonense*, *Ramphicarpa tubulosa*, and other root parasites do. The Acanthaceae are represented by *Thunbergia atriplicifolia*, *Blepharis longispica*, *Barleria obtusa*, *Crabbea hirsuta*, *Adhatoda natalensis*, *Peristrophe natalensis*, and many others, but the family is on the whole chiefly characteristic of the warmer coast belt.

The Asclepiadaceae are abundant and mostly early flowering. *Raphionacme, Asclepias, Xysmalobium, Schizoglossum, Sisyranthus* are all represented by numerous species. *Hebenstreitia* and *Sclago* (Selagineae) are also represented by several species. *Lippia asperifolia* (Verbenaceae) is very common. The Labiatae include *Ocimum obtusifolium, O. obovatum* (uFukuzela), *Orthosiphon inconcinnus, O. macranthus, Plectranthus calycinus, P. tomentosus, Leucas martinicensis*, species of *Stachys, Ajuga ophrydis*, and many others.

Among the Thymeliaceae the genus *Lasiosiphon* is most important, including *L. linifolius* (isiDikili), *L. kraussii, L. anthylloides* var. *macrophylla, L. splendens*, The Euphorbiaceae are represented by various species of *Euphorbia, Cluytia*, and *Acalypha*.

The Monocotyledons are so very abundant, that no attempt will be made to name species. The Orchidaceae are represented by the genera *Habenaria, Disa, Satyrium, Brownleea, Eulophia, Lissochilus, Brachycorythis, Disperis, Corycium* and others, though a great number of the species belong to the hydrosere.

The Iridaceae include *Moraea, Aristea, Hesperantha, Dierama, Watsonia, Tritonia, Acidanthera, Crocosmia, Gladiolus, Antholysa*, and others.

The Amaryllidaceae include *Hypoxis, Anoiganthus, Apodolirion, Crinum, Brunsvigia, Nerine, Cyrtanthus, Haemanthus, Buphane*, and others.

The Liliaceae include *Asparagus, Aloe, Kniphofia, Bulbine, Eriospermum, Anthericum, Chlorophytum, Tulbaghia, Drimia, Dipcadi, Galtonia, Albuca, Urginea, Drimiopsis, Eucomis, Scilla, Ornithogallum, Androcymbium*, and others.

The detailed plant ecology of these associated plants has hardly been studied. We know the distribution of only very few of them. It would not have been worth our while dealing with them even to the extent which has been done, were it not that it emphasizes, by the reference to concrete examples, the tremendous variety that is found. Economically, many of them are of importance chiefly in the wrong direction, since various stock diseases result from their being eaten. The ecological study of the flowering plants of the Veld as distinct from the grasses should be undertaken, since

such a large proportion of the total flora is involved, and undoubtedly there are many interesting problems to be encountered.

Grass burning has the effect of generally increasing the abundance and extent of vernal aspect societies since their development as pointed out above depends so much on their being able to make an early start in Spring. If the old grass is burnt off the surface of the soil is heated more easily, the numerous aspect flowering plants obtain the necessary rise in temperature, and they are able to spread considerably before the grass grows tall enough to stop their growth by shading them. This goes on year after year. Vernal aspect societies are relatively rare in veld that has been left unburnt.

Aestival and Autumnal Aspects.

It is hardly worth while distinguishing between these in the Eastern grassland of South Africa. The grasses during summer grow taller, and there is always a rise in the level of each succeeding aspect. The numerous vernal aspect societies cease to be so prominent, though of course they have not disappeared. As a matter of fact, many of the species mentioned above continue to be found in flower through the summer months, but even if a species flower fairly late, it may belong to the vernal aspect, if it is more conspicuous in the Spring. The great majority of the Veld plants are vernal, for in Autumn the rank growth of grass tends to hide everything. The chief autumnal societies really belong to transitional types, the species being usually shrubby. Only a few widespread examples will be mentioned.

The Bracken fern *Pteris aquilina* is one of the most important. Among the Compositae *Artemesia afra* (umHlonyane) and several species of *Vernonia*, *Aster*, *Nidorella*, *Athanasia*, *Helichrysum*, *Berkheya*, *Senecio* are frequent, in fact compared with the others, this great order is even more prominent in the autumn than in the Spring. The Leguminoseae, on the other hand, are not so prominent in autumn. Few examples of the Asclepiadaceae, so abundant in Spring, can be found in autumn. The bulbous Monocotyledons, too, are much reduced, though a few, *e.g.*, *Watsonia densiflora*, form rather extensive societies. The Labiatae include one widespread example, *Leonotis leonurus* (iMunyane). Apart from the grasses, to the plant collector the Veld in autumn appears a singularly barren field, when he compares it with the almost overwhelming profusion of flowers found there in the Spring.

The effect of grass burning on the autumnal aspect societies is exactly the opposite of that on vernal aspect societies. The former are often transitional to forest, or at any rate represent post climax phases of the succession, and they are kept in check or even destroyed by grass burning. They are not favoured by having the ground laid bare in Spring as the vernal aspect societies are, they do not have the same large underground storage organs, temperature for them is not such an important factor, and in every respect they differ in their ecological behaviour from the lower growing, earlier developing, vernal species.

The Transition to Woodland (Post climax grassland).

A great deal of the Eastern grassland at the present time occupies what are natural Forest climatic habitats. The South Eastern slopes of the High Veld in Natal very commonly do bear Forests if they have not been destroyed, and over most of the High Veld timber trees may be successfully grown. If Grassveld, which occupies such Forest areas, is left unburnt for a number of years, the early stages of a Forest sere soon make an appearance.

The first stage is usually the replacing of Andropogon-Anthistiria Veld by taller Andropogon species of the Cymbopogon section—the grasses which are commonly referred to as Tambookie. The Tambookie consocies that is most frequent is one dominated by *A. nardus* var. *validus*, a lemon scented grass known to the natives of Natal as isiQunga and used by them medicinally. *A. dregeanus* (uQunga), another equally tall species, is also common, and *A. auctus* (also called uQunga), which is rather like *A. hirtus*, but taller, is a third member of the associes. The three species are often mixed. At the present time attention is being directed to them in connection with the possible establishing of a paper-making industry in the Union. Other species of *Andropogon* which belong to the same transitional stage of the succession are not so common, *e.g.*, *A. plurinodis*, *A. rufus*, *A. dichroos* (a spring flowering species), *A. filipendulus*, *A. cymbarius* and its variety *lepidus*. The Tambookie and other taller Cymbopogon associes are not confined to the early stages of the Forest sere. They are also characteristic of the hydrosere and often occur in the sub-sere, where land has been cultivated.

There are several other grasses which are characteristic of the early Forest stages:—*Erianthus capensis* (umTala) and

E. sorghum, *Arundinella ecklonii*, *Phalaris arundinacea*, *Setaria sulcata*, *S. lindenbergiana*, *S. nigrirostis*, *S. flabellata*, *S. aurea*, *Pennisetum unisetum*, and occasionally other of the Vlei Pennisetums, *Panicum crus-pavonis* and sometimes other Panicums *Sporobolus rehmanni*, most of which also belong to the hydrosere.

In the transition to Forest the grasses soon begin to give way to shrubs or other flowering plants. The Bracken fern, too (*Pteris aquilina*) sometimes covers large areas to the exclusion of everything else. Composites like *Athanasia acerosa*, *Artemesia afra*, *Berkheya platyptera* often form quite large consocies. At the higher altitudes, *Myrsine africana* is a common Forest pioneer. *Leucosidea sericea* gradually establishes definite *Leucosidea* or Oudehout Scrub, which in turn progresses towards Yellow-wood (Podocarpus) forest. *Buddleia salviaefolia* is a very frequent precursor of Scrub and Forest also, all over the midlands and mountain regions of Natal. At Nottingham Road, Natal, on the farm of Mr. James King, there is an area of over 60 acres which has been protected from grass fires by fire-breaks for over thirty-five years. Through the kindness of Mr. King, I have been able to make a careful study of it. The various stages of the succession are clearly shown. 1st, Tambookie grasses the species named above. 2nd, *Athanasia*. 3rd, *Buddleia salviaefolia*, *Leucosidea sericea*, *Erica cooperi*, species of *Rhus* and *Lasiosiphon*. 4th, young Yellow-wood Bush. There is no Anthistiria Veld left, though I am assured by Mr. King that the inSinde used to be dominant over the whole area.

Farmers whose farms lie in the Forest climatic areas will usually find that, if they refrain from burning the grasses of their Veld, the succession progresses in the same direction. The grasses grow taller and coarser, and gradually the finer grasses are ousted. Burning then becomes necessary to keep back the succession. It may be urged that such farmers would probably find the planting of timber a better financial proposition than the pasturing of cattle, but if they must have pasturage, then they must continue to burn the grasses. Forest soils are usually not rich, and the grasses do not as a rule give a good pasturage at any stage of the succession.

There are other transitions from grassland to scrub, which follow different lines. In the Low Veld, and in all the various types of Bush Veld, etc., the succession is that given in detail in one of my former papers. Isolated trees, usually

Acacia thorn trees, germinate among the Anthistiria-Andropogon grasses. They grow up and form a park-like type of vegetation. Birds alight on their branches, and bring the seeds of numerous other species, which are deposited underneath the pioneer trees, and grow up in their shade. Clumps of trees are thus formed, and as the clumps grow closer Thorn thickets are established. The climax type is Scrub. For full details see S.A. Journal of Science, November, 1917, where a list of over 230 species of Thorn Veld trees and shrubs is given, with an account of their relative frequency and behaviour in the plant succession.

The Hydrosere.

The initial stages develop along the margins of Vleis and ponds, and along the stream banks, and consist of hygrophilous consocies. The variations (1) in the amount of water present and (2) in the degree of stagnation of the water determine the different types. In the larger Vleis, different stages of succession are marked by a more or less perfect zonation, the earlier stages being nearest the centre of the Vlei and the later transitional stages being on the side nearest to the Veld grassland. In the smaller Vleis and along the stream banks, only a few of the stages are represented at any one spot.

The first stage consists of floating or submerged aquatic plants of which two types may be distinguished:—

(1) In well aerated, running water, Mosses and Hepatics with a few well developed Algal communities, and such plants as *Hydrostachys natalensis*, *Triglochin laxiflorum*, *T. striatum*, *Eriocaulon woodii*.

(2) Less well aerated standing water. Algae more numerous, Mosses and Hepatics less abundant, and more numerous aquatics, *e.g.*, *Marsilea macrocarpa*, *Lemna minor*, *L. gibba*, *Callitriche bolusii*, *Limnanthemum indicum*, *Myriophyllum spicatum*, *Pistia stratiotes*, *Nymphaea stellata*, *N. capensis*, *Ceratophyllum* sp., *Aponogeton natalense*, and several species of *Utricularia* and *Potamogeton*.

The second stage is represented by various zones of tall Cyperaceae and *Phragmites communis* with *Typha capensis*. *Phragmites* lines many of the streams for long distances and *Typha* forms very definite consocies or occurs mixed with the Phragmites and sedges. *Cyperus immensus* is the tallest of the sedges, but *C. latifolius* is the commonest. *Cyperus fastigiatus* is also common, and there are a great many others

belonging to the genera *Cyperus*, *Mariscus*, *Carex*, *Rhynchospora*, and *Scleria*, which also grow tall and form consocies at this stage. In Zululand, the Papyrus (*C. madagascarensis*) forms very large consocies. There is usually a large admixture of small Cyperaceae species of *Kyllinga*, *Pycreus*, *Fimbristylis*, *Bulbostylis*, *Scirpus*, *Ficinia*, *Fuirena* and *Carex*.

The third stage is dominated chiefly by Vlei grasses. The following form definite consocies: *Imperata arundinacea*, *Erianthus capensis*, *E. sorghum*, *Eragrostis nebulosa*, *Pennisetum unisetum*, *Setaria aurea*, *Leersia hexandra*, *Panicum crus-pavonis* var. *rostratus*, *Arundinella ecklonii*, *Phalaris arundinacea*. The following occur mixed with others, few of them ever assuming dominance:—*Saccharum munroanum*, *Ischaemum fasciculatum* (coast), *Rottboellia compressa* var. *fasciculata*, *Paspalum scrobiculatum*, *P. distichum*, *Panicum aequinerve*, *P. maximum*, *P. proliferum* var. *paludosum*, *P. interruptum*, *Setaria imberbis*, *S. nigrirostis*, *S. gerrardi*, *S. rigida*, *Pennisetum natalense*, *P. sphacelatum*, *P. thunbergii*, *Stenotaphrum glabrum*, *Trichopteryx dregeana*, *Diplachne fusca*, *Agrostis lachnantha*, *A. natalensis*, *A. phalaroides*, *Eragrostis namaquensis* var. *robusta*, *Leptocarydion vulpiastrum*, *Polypogon monspeliensis*.

Of the flowering plants there are many hundreds. A fairly complete list might be compiled, even with the information at present available, but it would make somewhat dull reading, so only the representative genera will be mentioned. These are:—*Ranunculus*, *Nasturtium*, *Hypericum*, *Geum*, *Alchemilla*, *Tillaea*, *Drosera*, *Berardia*, *Gunnera perpensa* (uGoba, dominant sometimes), *Dissotis*, *Lythrum*, *Epilobium*, *Jussiaea*, *Ludwigia*, *Sium*, *Anthospermum*, *Galium*, *Adenostemma*, *Aster*, *Nidorella*, *Denekia*, *Amphidoxa*, *Achyrocline*, *Helichrysum*, *Leontonyx*, *Matricaria*, *Senecio*, *Lobelia*, *Chironia*, *Sebaea*, *Myosotis*, *Diclis*, *Limosella*, *Hysanthes*, *Veronica*, *Sopubia*, *Bopusia*, *Utricularia*, *Mentha*, *Teucrium*, *Polygonum*, *Rumex*, *Eulophia*, *Lissochilus*, *Stenoglottis*, *Huttonaea*, *Satyrium*, *Disa*, *Brownleea*, *Schizochilus*, *Disperis*, *Moraea*, *Gladiolus*, *Antholyza*, *Anoiganthus*, *Crinum*, *Clivia*, *Kniphofia*, *Drimia*, *Urginea*, *Ornithogalum*, *Richardia*, *Xyris*, *Commelina*, *Juncus*, *Eriocaulon*.

The fourth stage consists of Tambookie associes exactly similar to the transitional grassland described above as representing the beginning of a Forest sere and the climax stage is Veld.

Subseres in Cultivated or Waste Land. Ruderal Species.

These result from man's interference and are very widespread, occurring not only in all cultivated land, but also along roadsides and along the railway tracks, and in waste land generally. The first stage is represented by numerous weeds of cultivation, mixed with grasses. The weeds are of considerable interest to the farmer, and, therefore, a fuller list is given than was thought necessary in the case of plants belonging to the other seres. Many of the weeds are exotics. The following occur chiefly in Natal. The other parts, I have not had an opportunity of observing in detail.

The Compositae are again best represented, including *Bidens pilosa* (the Black jack), *Erigeron canadense*, *Tagetes minuta* (Khaki weed), *Xanthium occidentale*, *X. spinosum*, *X. italicum*, *Zinnia pauciflora*, *Siegesbeckia orientalis*, *Galinsoga parviflora*, *Schkuria bonariensis*, *Acanthospermum brazilum*, *Centaurea solstitialis*, *C. melitensis*, *C. caliitrapa*, *Ageratum conyzoides*, *Tridax procumbens*, *Eclipta erecta*, *Crepis japonica*, *Lactuca capensis*, *Spilanthes africana*, *Sonchus oleraceaus*, *Cnicus lanceolatus*, *Chrysocoma tenuifolia*, *Helichrysum foetidum*, *Oligocarpus calendulaceus*.

The next most important family is probably the Solanaceae, which includes *Solanum nigrum*, the berries of which are eaten, *Solanum sodomaeum* (Devil's apples), *Physalis peruviana* (Cape Gooseberry), *Nicandra physaloides*, *Datura stramonium* (Stinkblaar). All of them common and widespread.

Species of Malvaceae are also common, including *Hibiscus trionum*, *H. cannabinus*, *H. physaloides*, *Abutilon indicum*, *Sida longipes*, *S. rhombifolia*, *Malva parviflora*. Some of these are possibly useful sources of fibre.

There are numerous Labiatae, *e.g.*, *Ocimum obtusifolium*, *Hyptis pectinata*, *Leucas martinicensis*, *Teucrium capense*, *T. riparium*, *Ajuga ophrydis*, and more than one *Plectranthus*.

The Scropulariaceae include *Diclis reptans* and the very troublesome witchweed *Striga lutea*, which is parasitic on the roots of the mealie, and often does a great amount of damage.

It is rather surprising to find the Leguminoseae, which are so abundant in the Veld, poorly represented by only one or two species, *e.g.*, *Vicia sativa*, *Melilotus officinalis*.

Rumex acetosella is often a very troublesome weed and *R. obtusifolia* also occurs. The inkberries (or uMahedeni), *Phytolacca stricta* and *P. octandra* are very abundant often in waste land. The Mexican poppy *Argemone mexicana* spreads rapidly along roadsides and over rubbish heaps, etc. *Richardsonia pilosa* is a common road side species.

Other ruderal species may be listed together as follows:— *Sisymbrium capense, S. officinale, Lepidium capense, Sinapis retrorsa, Fumaria officinalis, Stellaria media, Spergula arvensis, Silene gallica, Portulaca oleracea, Oxalis corniculata, Oenothera biennis, Hydrocotyle asiatica, Spermacoce natalensis, Asclepias fruticosa, Wahlenbergia undulata, Anagallis arvensis, Cynoglossum enerve, Echium violaceum, Convolvulus arvensis, Ceratotheca triloba* (uDonquabathwa), *Barleria obtusa, Hebenstreitia integrifolia, Lantana salvifolia, Lippia asperifolia* (umSuzwane), *Verbena tenera, Plantago major, Mirabilis jalapa, Amarantus paniculatus, A. spinosus, A. thunbergii, Alternanthera achyrantha, Cyathula cylindrica, C. globulifera, Chenopodium ambrosioides, C. botrys, C. murale, Celosia trigyna, Polygonum aviculare, P. serrulatum, P. convolvulus, P. fagopyrum, Euphorbia sanguinea, E. peplus, E. hypericifolia, Acalypha eckloni, Ricinus communis* (Castor oil or umHlakuva), *Cannabis sativa, Urtica urens, Cyperus esculentus,* species of *Fimbristylis.*

Mixed with the weeds, there are a number of ruderal grasses. Some of them are cultivated either as fodder plants or by the natives or whites for the sake of their grain, *e.g., Paspalum dilatatum, Eleusine indica* (uMunyankomo), *E. corocana* (uPoko), *Pennisetum typhoideum* (Nyaloti), *Andropogon sorghum* var. *usorum,* etc. (Amabele or Kafir Corn), *Panicum miliare, Eragrostis abyssinica* (Teff grass), *Avena sativa* (Oats).

Both *Dactyloctenium aegyptiacum* and *Stenotaphrum glabrum,* as well as the Cynodons, are used for making lawns and often occur as ruderals.

Some of the other ruderal species are exotics, *e.g., Lolium temulentum, L. multiflorum, Holcus lanatus, Briza minor, B. maxima, Poa annua, P. trivialis, Bromus maximus, B. unioloides, Phalaris minor, Avena fatua, A. barbata, Panicum capillare.*

Among the indigenous grasses the Paniceae are best represented. *Digitaria ternata* is very common in cultivated

land and along roadsides in early spring. Others, *e.g.*, *D. tenuiflora*, *D. debilis*, flower later, and *D. horizontalis* and *D. sanguinalis* are very common in autumn. *Paspalum scrobiculatum* is another common species, and the genus *Panicum* is abundantly represented by *P. isachne*, *P. trichopus*, *P. helopus*, *P. arrectum*, *P. stagninum*, *P. crus-pavonis*, *P. crus-galli*, *P. laevifolium*, *P. meyerianum*, *P. proliferum* var. *longijubatum*. The species belonging to the section Brachiaria with secund spikes are commoner in Spring, the eu-Panicum species with spreading panicles in autumn. To the Paniceae also belong *Setaria gerrardi*, *S. aurea*, *S. nigrirostis*, *S. imberbis*, and what is probably the most important species of all, since it often assumes complete dominance, *Tricholaena rosea*.

Some of the annual species of *Eragrostis* and one or two of the perennials are always ruderal, *e.g.*, *E. major*, *E. annulata*, *E. ciliaris*, *E. aspera*, but a great many of the species, already mentioned as belonging to the early stages of the prisere, are frequent as ruderals, especially *E. curvula* and *E. plana*. The same applies to the numerous species of *Aristida*. They are abundant along roadsides and in cultivated land. Many of the Andropogons also occur, and *A. pertusus*, *A. intermedius* var. *punctatus*, *A. nardus* var. *marginatus* and *validus*, *A. halepense* var. *effusus*, *A. auctus*, *A. hirtus*, *A. dichroos* are all common.

The genus *Chloris* is typically ruderal, though rather nutritious grasses. *Ch. pycnothrix* is very common along roadsides in autumn. *Ch. virgata* and *Ch. gayana* spread somewhat through the Veld, in which the former sometimes forms consociations.

The succession varies so much in different parts that it is somewhat difficult to analyse. In general, it may be said, that the annual species are superseded by the perennial, but often in waste land the very first species of grasses to appear are the tall growing *Cymbopogons*, and often also Eragrostis-Aristida associes have taken complete possession of cultivated land in a few months. *Tricholaena rosea*, a sub-perennial, often assumes a wide dominance for a year or two and represents a "Short lived grass stage." The actual succession in different spots depends chiefly on what seeds arrive in quantity first.

With regard to the economic side of the question, this succession has many points of interest. Most of the early

weed stages are undesirable and some are particularly "noxious," *e.g.*, *Xanthium*, *Acanthospermum*, *Cnicus*, *Centaurea*, *Tagetes*, *Schkuhria*, *Galinsoga*, *Rumex*, *Amarantus*, *Cyathula*, *Striga*, *Phytolacca*, *Argemone*, *Alternanthera*, etc. Others are eaten by stock, *e.g.*, *Bidens pilosa*, the Blackjack, one of the commonest. Many of the grasses are palatable and nutritious, *e.g.*, *Digitaria ternata*, *Eleusine indica*, *Chloris spp.* What seems rather surprising is that farmers do not more often try to control the succession. It is usually left to chance to determine what seeds are present, and what crop of ruderals will come up after the cereals, etc., are reaped. Some farmers do encourage such species, as they have proved capable of providing good pasturage, but a great deal more might be done, by sowing the seeds of the better species or of exotics if these are found to be more suitable, though some farmers object to this method on the ground that it spoils the main cereal crop.

Other Subseres. The Plant Succession in Dongas.

The study of this succession has a very important bearing on the question of soil erosion. While soil erosion must necessarily continue to take place at a certain rate, there is little doubt that since the land has been taken up by white settlers in South Africa, it has largely increased. The chief causes have already been referred to. The burning of the grass lays bare the surface of the soil, and tends to destroy the protective mat of vegetation. It tends to send back the plant succession to the earlier stages, where the grasses grow in more isolated tufts. The pasturing of large herds of cattle and sheep tends to the hardening of the surface layers of soil, which increases the run-off of water, and the formation of numerous cattle tracks tends to guide the flow of water into definite channels, which quickly deepen into Dongas. The process is always to a certain extent checked by the vegetation itself, and incipient Dongas are sometimes filled with rank growth, which prevents further erosion.

The species, which occur, depend on the size which the donga has attained. *Pteris aquilina*, the Bracken fern, sometimes fills shallow dongas. Some of the species of *Cyperus*, *Mariscus*, and *Carex* act in a similar manner, and among the grasses the more deep rooted species are of prime importance. The *Aristidas* and *Eragrostis* species are much in evidence, as well as the species described above as belonging to the hydrosere, especially the later stages of it, with *Pennisetums*,

Setarias, Erianthus, Leersia, Panicum crus-pavonis, Phalaris arundinacea, Arundinella, Eragrostis nebulosa, etc., and most important of all the Tambookie associes, *A. nardus* var. *validus, A. auctus, A. dregeanus.*

As the donga deepens and extends backwards from the upper end, the sides fall in and the soil gets washed away. The grasses then are confined to the sides and the mid-channel is left bare. Birds and other animals seek shade and shelter in the dongas and bring a great variety of seeds. Shrubs and trees, if these are present in the neighbourhood, are brought in in considerable variety and soon the donga vegetation becomes very mixed indeed. As the shrubs and young trees grow up only the shade-loving grasses, *e.g.*, species of *Panicum, Stipa*, etc., are able to persist. The climax stage, which, however, is not a very stable climax, is Rocky Stream-bank Bush with such species as *Rauwolfia natalensis, Combretum kraussii, C. salicifolium, Ficus capensis, F. natalensis, Rhamnus prinoides, Celtis kraussiana, Trema bracteolata, Grewia lasiocarpa, G. occidentalis, G. caffra, Buddleia salviaefolia, Brachylaena discolor, Cussonia spicata, Calodendron capense, Nuxia floribunda, Xymalos monospora, Helinus ovata, Celastrus buxifolius, Hippobromus alata, Ehretia hottentottica, Jasminum spp., Zizyphus mucronata, Acacia spp., Royena spp, Pavetta spp., Randia rudis, Xanthoxylon capense, Euclea spp, Elaeodendron spp*, and at higher altitudes *Leucosidea sericea.*

Dongas may be caused to silt up by placing an obstruction at the lower end, and sometimes natural obstructions occur through fallen trees, etc. Above all, the earlier grass stages in a donga succession should never be burnt, since they do much to bind the soil and check the process of erosion.

THE COAST BELT AND COAST LINE OF NATAL.

The Psammosere. Litoral Species. The whole coast line along the Eastern side of South Africa is low-lying without any extensive development of cliffs. The line of sand dunes, which varies from 50 to 200 feet in height and from a quarter of a mile to half a mile in width, is clothed for the most part with Psammophilous Bush, which represents the climax stage of the succession. The only interruptions are the Mangrove associations at the river-mouths. The plant succession on the strand, *i.e.*, on the shifting belt of sand between the fixed dunes and the sea, is a very clearly defined one. At

certain places, *e.g.*, Amanzimtote, there is a broad belt next the sea where *Hydrophylax carnosa* is completely dominant, and almost the only plant present. Another belt nearer to the shore is sharply marked off, and stands 2-3 feet higher. Here *Scaevola lobelia* is dominant and *Gazanea uniflora* subdominant, At other places, *e.g.*, north of Durban, *Ipomaea pes-caprae* (*I. biloba*) covers long distances. There is also present *Cyperus natalensis*, and occasional plants of *Sporobolus pungens*. These various strand consocies and associes gradually become more mixed, including such plants as *Cynanchium obtusifolium*, *Cryptostemma niveum*, *Osteospermum moniliferum*, *Dimorphotheca fruticosa*, *Helichrysum teretifolium*, *Salicornia herbacea*, *Tephrosia canescens*, *Passerina ericoides*, *Brachylaena discolor*. Close to the Bush, *Mesembrianthemum edule* is often dominant in patches. Finally the Psammophilous Bush becomes established with usually Red Milkwood (*Mimusops caffra*) dominant, and a great variety of other trees and lianes present, but with little undergrowth.

The above is the typical succession along the more exposed parts of the coastline, but in the sheltered nooks and small bays there is a distinct succession, where certain grass consocies play an important part.

(1) Nearest the sea, washed by the spray at all times and covered by the sea at high tides, as shown by the position of driftwood, there is a pure consocies of *Sporobolus pungens*.

(2) A few yards further up, it is replaced by *Stenotaphrum glabrum*, a prostrate rooting species with ascending culms. It often forms associes with *Dactyloctenium aegyptiacum*, which is also prostrate and rooting at the nodes. In places the latter becomes dominant.

(3) Still further up and close to the Bush, there is an admixture of other species, *e.g.*, *Panicum maximum*, *P. meyerianum*, *P. zizanioides*, *Ehrharta calycina*, *Eh. erecta*, *Eleusine indica*, *Sporobolus indicus*, *Eragrostis curvula*. The final stage is again Psammophilous Bush.

While the Bush, as a whole, is dense and impenetrable, there are many open glades and footpaths, and around the margins there are found areas, which are covered with less dense Scrub, which is transitional to Veld or more often to Vleis. In such open spaces and along the margins of the Bush, a most interesting variety of grasses occur, most of them confined to the coast belt of Natal, or only occurring elsewhere in the northern tropical parts of the Transvaal.

These include *Ischaemum fasciculatum* var. *arcuatum*, *Andropogon rufus*, *Digitaria diversinervis*, *Panicum brizanthum*, *P. filiculme*, *P. hymeniochilum*, *P. aequinerve*, *P. chusqueoides*, *P. perlaxum*, *P. zizanioides*, *P. meyerianum*, and in denser shade *P. laticomum*, *Oplismenus africanus*, *Potamophila prehensilis*, all tropical forms. A number of other Coast Veld species of wider distribution are mixed. Some of the Cyperaceae are often dominant, *e.g.*, *Cyperus albostriatus*, *C. esculentus*, *Mariscus dregeanus*.

The Xerosere. The earlier stages of this, on the coast belt, do not differ in any essential points from the Veld of higher altitudes. The initial stages are again dominated by *Aristida*, *Eragrostis*, and *Sporobolus*. *E. curvula* is abundant, *Aristida* not quite so common. *Sporobolus subtilis* is not recorded elsewhere for South Africa, but occurs in Madagascar. *Sporobolus indicus* is again common.

In the subsequent stages, patches of typical Anthistiria-Andropogon Veld occur, usually with *A. hirtus* dominant. *Pollinia villosa* is rather frequent. *Pogonarthria falcata* shows connections with the Transvaal, as also *Andropogon hirtiflorus* and *Perotis latifolia*. After a careful examination of much of the Coast Veld of Natal, I have no hesitation in saying that none of it is stable, nor does it represent more than a transitional phase to Bush, towards which it is progressing very rapidly, wherever it is left alone. The Tambookie grasses are often pioneers of Bush, but the various tropical Panicums named above as well as others (*P. brizanthum*, *P. filiculme*, *P. hymeniochilum*, *P. aequinerve*, *P. perlaxum*, *P. chusqueoides*, *P. deustum*, *P. zizanioides*, *P. maximum*, *P. laevifolium*, *P. meyerianum*, *P. proliferum*, *P. crus-pavonis* var. *rostratum*, *P. curvatum*) and *Ischaemum fasciculatum* var. *arcuatum*, *Digitaria diversinervis*, *Setaria sulcata*, *C. verticillata* make the transitional belt on the coast very distinctive.

Among the flowering plants there are also many distinctive species, which act as pioneers. *Vangueria infausta* is one of the most important pioneer trees on the coast. *Cussonia umbellifera* is also abundant. In the final stages *Albizzia fastigiata*, *Protorhus longifolia* are often dominant, but the semi-tropical nature of the bush is most strikingly shown by the presence of palms (*Hyphaene crinita*, *Phoenix reclinata*), and the Wild Banana *Strelitzia augusta*.

The Hydrosere. This differs even less than the xerosere from the midland Veld of Natal. The chief difference lies in the relative greater abundance of certain species, especially *Imperata arundinacea*, *Ischaemum fasciculatum* var. *arcuatum*, *Rottboellia compressa* var. *fasciculata*, *Panicum interruptum*, *Leptocarydion vulpiastrum*, *Diplachne fusca*, *Stenotaphrum glabrum*, *Trichopteryx dregeana*, *Eragrostis namaquensis*, though most of the other hygrophilous species occur. *Phragmites communis* lines the rivers for long distances. In Zululand *Cyperus madagascarensis*, the Zululand Papyrus, is of considerable importance.

As a climax type, the Barringtonia consociation, which occurs in wet sandy soils, is of interest.

The Halosere. The early stages have *Salicornia* and *Chenolea diffusa*, the climax Mangroves, *Avicennia officinalis*, *Bruguiera gymnorhiza*, and *Rhizophora mucronata*. This occurs at the river mouths on the mud flats, and grasses hardly enter into it, except sometimes *Sporobolus pungens*, but it is difficult to draw any hard and fast line between the halosere and the psammosere as the soil water in the latter is sometimes brackish, sometimes not. The psammosere also merges into the hydrosere, since the sand is usually not dry, but on the contrary rather moist. As a rule the climax stages of the psammosere are more mesophytic than the initial stages, but not always.

MOUNTAIN TUSSOCK GRASSVELD.

This very distinct type of grassland occurs on the slopes of the Drakensberg, at altitudes of 4,000-8,000 feet, extending all the way round to the Stormberg, and it is also characteristic of other foothill ranges in Natal and the Eastern Cape Colony. The grasses grow in densely caespitose tufts as a rule, and they are rather xerophytic forms with setaceous or sub-setaceous or firmly folded or convolute leaves. The old leaf bases persist forming dense stools or tussocks, which collect the usually red soil, and stand up a few inches above the level of the rest of the ground. There are very narrow bare spaces between the tussocks.

While there is sometimes a certain amount of mixing with Anthistiria-Andropogon Veld species, the Tussock Veld is on the whole very distinct in its composition also. Aristida is rather poorly represented, but *A. bipartita*, *A. angustata*,

A. adscensionis, *A. burkei*, and *A. congesta* occur. *Eragrostis chalcantha*, *E. curvula*, *E. chloromelas*, *E. caesia*, *E. micrantha*, *E. plana*, *E. brizoides*, *E. gummiflua* represent the other great pioneer genus.

Since all Tussock Veld is of a primitive type, Aristida or Eragrostis consocies have not the same importance in establishing it, as they have in the case of Anthistiria Veld. They occur in the climax stages of it, and are sometimes dominant over patches, but they are not so characteristic of it, as the species named below. *Cynodon dactylon* is often a pioneer over bare ground. The following are all definite mountain veld species: *Microchloa caffra*, *M. altera* var. *nelsoni*, *Harpechloa capensis*, *Festuca caprina* (bok-baard), *F. costata*, *F. longipes*, *F. scabra*, *Poa binata*, *Koeleria cristata*, *Anthoxanthum ecklonii*, *Avenastrum turgidulum*, *A. caffrum*, *Agrostis suavis*, *Sporobolus centrifugus*, *Triraphis rehmanni* (rare), and *Stiburus alopecuroides* (in the hydrosere). On the Tabamhlope mountain, Natal, there occurs the interesting and distinctive rare species *Ischaemum franksae*, which is also a tussock former.

The most striking feature of this list is the greater representation of the temperate tribes, which are almost absent from the Veld of lower altitudes. The Aveneae include *Avenastrum*, *Anthoxanthum*, *Koeleria*, the Agrosteae *Agrostis* and the Festuceae *Stiburus*, *Festuca*, *Poa*, and *Brachypodium*, all temperate forms. The others belong to the Chlorideae.

The ordinary Eastern Grassveld species, as already mentioned, are not altogether absent. Galpin records *Anthistiria imberbis* from an altitude of 9,400 feet on the eastern shoulder of Ben McDhui and *Elionurus argenteus*, *Andropogon ceresiaeformis*, *A. eucomus*, *A. appendiculatus*, *A. schirensis*, *A. amplectens*, *A. filifolius*, *A. distachyus*, *A. contortus*, *A. nardus* var. *marginatus*, *A. schoenanthus* var. *versicolor*, *A. hirtus*, *A. auctus*, *Panicum natalense*, *P. ecklonii*, *P. serratum*, *Digitaria monodactyla*, *D. tricholaenoides*, *Axonopus semialatus* var. *ecklonii*, *Setaria spp.*, *Pennisetum spp.*, *Tricholaena setifolia*, *Arundinella ecklonii*, *Tristachya leucothrix*, *Diplachne biflora*, *Chloris virgata*, *Ch. petraea* are all found.

The dominant species, however, are those named in the first list. It is difficult to declare any one or two species as being dominant, since all mountain Tussock Veld is of a semi-open character. The species grow very much mixed.

It is chiefly in the vernal aspects that the temperate species are most in evidence. As summer advances, those members of the more tropical tribes (which are taller growing forms) tend to a certain extent to make the Tussock Veld lose its distinctive character and to appear more like the normal type of Eastern Grassveld. Unless it is visited at different times of the year, a very false idea is obtained of its real nature and composition.

Other mountain species of the Drakensberg.

At high altitudes, mixed with Scrub and Macchia or growing in isolated tufts among rocks and in ravines, there are a number of species which do not form grasslands. *Andropogon appendiculatus* often belongs to this class, but the most interesting species are those which show connections with the South Western region. There are several species of *Danthonia*. *D. stricta*, *D. disticha*, *D. macowani*, and a species near *D. papposa*, an unnamed species of *Pentaschistis* (*fide* Galpin), *Melica bolusii*, *Lasiochloa longifolia*, *Avenastrum antarticum*, *Achneria setifolia*, *Achneria* sp. nearest *microphylla*, *Anthoxanthum dregeanum*, *A. brevifolium*, *Brachypodium bolusii*, *B. flexum*, *Agrostis subulifolia*, *A. barbuligera*, *A. bergiana*, *A. eriantha*.

Mountain grasses generally (including those of the Tussock Veld) are xerophytic, but at the same time very good grazing grasses, especially the members of the Chlorideae and the temperate tribes. They are, however, slower growing than the grasses of lower altitudes. They stand frost well and are early flowering.

V.—Economic Applications.

In the course of the above study of the plant succession in the grassland of South Africa, many economic questions have been touched upon, particularly those concerned with grass-burning, stock grazing, feeding value of natural grasses, the cultivation of grasses, and soil erosion. It may be well in this short concluding section to summarize the main conclusions.

Grass burning. It is important to remember that the effect of grass burning depends on the type of grassland concerned, the stage at which the plant succession has arrived, and the time of year at which the burning is carried out.

1. If the Grassveld is of a primitive or semi-open type with species of *Aristida* (Steek gras, wire grass, umGongoni), or *Eragrostis* (umRrepuRrepu, umTshiki), or *Sporobolus* (umSingisan) dominant, grass burning prevents the plant succession going any further, and makes the primitive type the final type. Since the grasses named are not so good as others which appear later, the veld remains less nutritious than it might be. On the other hand the young shoots of those pioneer grasses, which appear after burning, are more palatable, being softer, than the same grasses when older and coarser, and many of them cattle refuse to eat them, except after burning. Species of *Eragrostis*, *Sporobolus*, and even *Aristida* are not without value as grazing grasses, and many farmers seem to prefer to continue burning so as to obtain the young growth as early as possible in Spring, rather than to allow the Grassveld a chance of progressing towards a better type, by refraining from burning. Of course in the drier regions, the climate itself may prevent the plant succession from progressing beyond the initial stages.

2. If the Grassveld has developed further, and a more stable type has been produced with *Anthistiria* (Red grass, Rooi gras, inSinde, or in the Low Veld Blue grass) dominant, and species of Andropogon and many others sub-dominant, the grasses should be grazed down, but not burnt, unless the succession shows signs of proceeding still further and coarse, tall Andropogons, together with various shrubs, take possession, *i.e.*, unless the succession progresses towards Scrub and Forest. *Anthistiria* is admittedly a very good grass, both for

grazing and when cut as hay. It rarely acts as a pioneer for it prefers to develop in its early seedling stages in shade, but it gradually overcomes the primitive types by shading them, and by depriving them of water, as explained more fully in a previous section. Its renewal buds are intravaginal, and above ground, and it does not stand burning well. The effect of burning is to send back the succession a step, which leads to the establishment of the more primitive types dominated by *Aristida*, *Eragrostis* and *Sporobolus*.

3. If the plant succession has gone still further, and tall, coarse, Tambookie grasses (*Andropogon nardus* var. *validus*, *A. auctus*, *A. dregeanus*, etc.) have developed together with numerous shrubs, and even seedling forest trees, or even if some of the species belonging to the earlier stage (*e.g.*, *Andropogon hirtus*) have grown rank and coarse, then the Veld must be burned, provided grazing is required. In other words, the plant succession must deliberately be sent back. Such Veld is progressing towards Forest. and the planting of trees in such places will be found to be a very sound procedure from the financial standpoint. Trees grow so very rapidly here that not so very many years need elapse before a better return may be obtained from them than from the pasturing of stock.

4. With regard to the time of the year when burning, if it must be done, should be done, most farmers agree that it is best to burn late in autumn. If the burning is done too early, new growth commences also very early, and the young shoots suffer from frosts, and early burning also prevents the grasses seeding. The only advantage in burning early is to get a certain amount of winter food for the stock or to get grazing as early in Spring as possible.

5. Other general effects of burning will be mentioned in connection with soil erosion, but one general effect, in addition to the sending back of the plant succession, is the increasing of the number, and extent of the numerous vernal aspect societies of flowering plants other than grasses, which occur in the Veld. The laying bare of the surface of the ground enables the sun's rays to raise the temperature of the subterranean storage organs, which nearly all those plants possess, and they develop early, and vigorously, in consequence. They are thus able to spread and multiply, and store up food for next year, when they spread still more. Some of them may be useful, but several of them are known to cause stock diseases, and an increase of them can hardly be considered

desirable. In Veld, that is left unburnt, they gradually diminish or almost disappear. In many places, especially on farms, where stock diseases are prevalent, this aspect of the subject may be found most important of all. Autumnal aspect societies, however, increase in Veld that is left unburnt.

Stock-grazing. The most obvious effect of grazing on the Grassveld is the tendency for the more nutritious grasses to be kept in check, and even eaten out altogether. The latter result, however, only happens when the Veld is over-stocked. Sheep and horses graze the herbage closer than cattle, and some species of grasses suffer more from sheep and horses in consequence. Ostriches eat the associated plants, and grasses increase on ostrich farms. Such natural consequences of grazing are to a certain extent unavoidable, and the only remedy is of course to grow fodder, and cut it, or in other words to bring the veld into cultivation.

There are, however, other effects of grazing, which are not quite so obvious, and of these the most important is the influence of the constant tramping on the soil. The surface layer is hardened and the run-off of water is increased. The peculiar ribbed appearance of hillsides and grassy slopes so universal in South Africa is due to the cattle always walking along the contour lines as they feed. The contour lines are marked out by cattle tracks one above the other at intervals of a few feet. The favourite watering places have cattle tracks leading to them also from all directions. Water runs along them and they soon deepen into channels, and then into dongas or ravines, the whole process being accelerated by the increased run-off of water. The phenomenon constitutes one of the most serious problems facing the farmer in South Africa. The remedy, which I have had an opportunity of seeing in operation, particularly on the farm of Mr. T. L. Fyvie, of Estcourt, is to fence the Veld into small paddocks. The cattle are thus prevented from continually and aimlessly roaming about, since they are not allowed to move on to fresh pasturage until they have grazed down one small paddock at a time. It is not a complete remedy but undoubtedly it helps, and in Mr. Fyvie's opinion, it does so to an extent which easily justifies the initial expenditure on the fencing.

The influence of stock grazing on the soil, and on the vegetation directly, leads to the establishment of more primitive grassland very much in the same way as burning the grass, the same species of *Aristida*, *Eragrostis*, and *Sporobolus*

assuming dominance. It is often difficult or impossible to say whether the change is due to burning or to grazing, or if to the latter, then whether the effect is directly the result of *Anthistiria* being eaten out, or the result of changed soil conditions. The only way in which the influence of the various factors can be analysed is by a series of controlled experiments on areas, where the vegetation has been carefully mapped. A series of permanent quadrats should be set aside and each should receive different treatment as regards burning, grazing, etc., one or more being left entirely untouched, and this should be done for every different variety of grassland. Some experiments of this nature are, I understand, being carried out by the Union Department of Agriculture, but of course several years must elapse before definite results can be obtained.

The feeding value of different types of grassland and grasses.

To a large extent, this is hardly a botanical question, since definite results can best be obtained by feeding tests, or by chemical analyses, if they are made at different times, and under varying conditions. The morphological appearance and ecological behaviour of the grass often enable the botanist to reach a conclusion regarding the *probable* value of a grass, but such conclusions must always be accepted with caution. Farmers also by continual observation of the kinds of grasses, that are most eaten, and the results, have reached conclusions, and in the course of my many botanical explorations, I have endeavoured to find out what those conclusions are. Wherever I have found a fair consensus of opinion I have noted it under each species dealt with in Part III. In other cases I must confess that opinions were too contradictory to be worthy of any attention.

The results for different types of grassland may be summarized as follows:—

1. The ruderal or land grasses which grow often with Mealie and other crops as weeds, and soon become plentiful or completely dominant in waste cultivated land, are on the whole rather good grasses, and some of them may be classed as very good, *e.g.*, the *Digitarias*, *Panicums*, *Eleusines*, and species of *Chloris*. *Cynodon dactylon*, which is often ruderal or a pioneer along pathways and on bare spaces, or old cattle kraals, etc., is also a good grass. *Tricholaena rosea* is not much valued here, though its seeds have been exported, and

it has been grown in India and elsewhere as a fodder grass. Unfortunately it is the species which most often assumes dominance, but the succession could easily be controlled by sowing the seeds of the better species.

2. Primitive grassland where the succession is at its earlier stages and species of *Aristida*, *Eragrostis*, or *Sporobolus* are dominant is of poor quality, though *Sporobolus* and *Eragrostis* are better than *Aristida*. Pioneer grasses are xerophytic and very hard and wiry and strong rooted. Cattle dislike them, because of the amount of fibres in their leaves, a feature illustrated in the figures given above. The young leaves in Spring are, however, softer and more palatable. *Sporobolus indicus* is sometimes cut for hay in autumn, and several of the less common species of *Eragrostis* are good grazing grasses.

3. All xerophytic grasses are not necessarily poor grasses. This is shown by the Veld around Molteno where the Haas gras, *Danthonia purpurea*, is dominant, which is one of the best types of veld in South Africa. It partakes of the character of Mountain Veld, another good type. It would appear that the grasses which belong to such temperate tribes as the Aveneae and Festuceae are more often nutritious grasses than the members of the Tropical tribes such as Andropogoneae, but our information on this point is not yet sufficient to enable us to speak with certainty. Xerophytic grasses are slow growing and for this reason are of less value.

4. When the plant succession has progressed far enough, so that Anthistiria-Andropogon associations constitute the climax stage or grassland formation, all the grasses are eaten, and the veld is considered good. This type of grassland covers enormous areas over the whole eastern side of South Africa. The glaucous varieties of Anthistiria are considered superior, forming the so-called Blue grass or Sweet Veld, but the actual composition of this differs only slightly from the other kinds.

5. In Forest climatic areas the succession progresses still further, taller coarser species of Andropogon become dominant mixed with various shrubs, and a type is established which is transitional to Forest. The grasses are not readily eaten and the Veld possesses little or no grazing value.

6. Mountain or Tussock grassveld is a very good type, many of the characteristic grasses being nutritious. It is interesting to note that here again temperate species are more

abundant. There is often, however, an admixture of xerophytic species of *Aristida*, *Eragrostis*, etc., which are much poorer.

A simple cross section of the leaf of a grass enables one to gauge the amount of hard sclerenchyma present, and consequently whether the grass is likely to be palatable to stock, but this is not a safe guide to the nutritive value of the grass, for many xerophytic species are nutritious in spite of their sclerenchyma. Xerophytic species, however, are slow growing as compared with the more mesophytic types, and this of course is a most important factor in connection with their value for pasturage.

In the cereal grasses, which have long been under the closest observation, it has been found that differences in the chemical nature of the grain are often correlated with simple morphological variations in the flower or in the plant itself, *e.g.*, the presence of hairs of a particular kind on the glumes of barley has been found to indicate that the variety is good for brewing purposes. It would be a very difficult matter to explain the reason for such correlations, but where they have been shown to exist they are extremely useful for the purposes of selection. I hesitate somewhat about laying stress on certain correlations which I have observed in South African grasses, which are known to be good grasses, but one such seems to be remarkable enough. The group of grasses which have their spikelets arranged on one side of the rachis, *i.e.*, secund (see Nos. 7-25 inclusive in the key to the genera) are nearly all good or very good grazing grasses. The tribe Chlorideae is best represented among them by the genera *Cynodon*, *Microchloa*, *Ctenium*, *Harpechloa*, *Chloris*, *Eleusine*, and *Dactyloctenium*. The tribe Paniceae has *Paspalum*, *Digitaria*, *Stenotaphrum*, and one section of the large genus *Panicum*. *Tetrachne dregei* (Festuceae) is also a good Mountain Veld species. If this correlation should be fully established, it will be extremely useful for it will enable anyone, at a glance, to recognize one very large class of useful grasses. It may be further noted that a large number of them belong to Mountain Veld.

The cultivation of grasses. The cultivation of the various cereals is a subject by itself, with which I do not propose to deal. Other grasses are cultivated for pasturage and fodder, or ensilage. Most of those commonly cultivated in other parts of the world, the seeds of which are listed by seedsmen, are

tried from time to time in South Africa, with varying degrees of success, as is to be expected from the exceedingly variable climatic conditions. *Paspalum dilatatum* is now extensively grown all over South Africa, and is one of the mose valuable. It prefers fairly moist conditions, but will live through drought. It does best at altitudes below 4,000 feet. *P. virgatum* resists frost and drought fairly well. It is more upright and taller than *P. dilatatum*. *Eragrostis abyssinica* (Teff grass) is an annual which is grown for hay very successfully over all the High Veld areas of Natal and the Transvaal. It is considered one of the best grasses that have been introduced. *Pennisetum longistylum* (Kikuyu) is a new introduction from British East Africa. It has creeping stems, which root at the nodes, and has to be propagated by planting. It prefers the warmer parts, but has been used successfully for making the lawns at the Union Buildings, Pretoria. It grows very quickly and is likely to prove most valuable for pasturage. It seems able to resist fairly adverse climatic conditions. *Phalaris coerulescens* (*Ph. bulbosa* or *Ph. commutata*) is rather widely grown over South Africa. It has vigorous growth and gives rich pasturage. It is hardy and frost resisting. *Chloris gayana* (Rhodes grass) is a native of South Africa (see in previous sections) and gives a good hay. It is rapid in its growth and drought resisting. *Eleusine indica* (uMunyankomo) and *Eleusine coracana* (uPoko) are also native grasses which give good pasturage.

The above are all well adapted for the Eastern side of South Africa where there is summer rainfall, though they may be grown successfully in other parts. In the regions of winter rainfall (the S. Western region) the native grasses, as we have seen, belong to temperate tribes, and there the European cultivated grasses are more at home, though, as a matter of fact, they are also grown on the Eastern side. The perennial rye grass (*Lolium perenne*), the Italian rye grass (*L. italicum*), the Red Fescue (*Festuca rubra*), the New Zealand Tall Fescue (*Festuca elatior* var. *arundinacea*), Sheep's Fescue (*F. ovina*), Slender Fescue (*F. tenuifolia*), Meadow Fescue (*F. pratensis*), Chewing's Fescue (*F. duriuscula* var.), Cocksfoot (*Dactylis glomerata*), Creeping Bent grass (*Agrostis stolonifera*), Tall oat grass (*Avena elatior*), Timothy (*Phleum pratense*), Crested Dogstail (*Cynosurus cristatus*), Rescue or Prairie grass (*Bromus unioloides*), Awnless Brome grass (*B. inermis*), Meadow grass (*Poa pratensis*), are all grown, usually being sown in mixtures as recommended by the seed merchants to suit wet or dry conditions, or sown singly.

For the making of lawns, the South African species *Cynodon dactylon*, *C. incompletus*, *Stenotaphrum glabrum*, *Dactyloctenium aegyptiacum*, are extensively used, as well as certain introduced species. The Kikuyu (*Pennisetum longistylum*) is likely to prove most useful for this purpose. *Agrostis stolonifera* and *Poa pratensis* are also sometimes used.

There are several other grasses, in addition to those mentioned above, which are being grown in S. Africa or experimented with by the Department of Agriculture of the Union, *e.g.*, Sudan grass (*Andropogon sorghum* var.), the Gramas (*Bouteloua oligostachya*, *B. curtipendula*), Indian Buffalo grass (*Panicum miliaceum*), Pearl Millet (*Pennisetum typhoideum*), Elephant grass or Napier Fodder (*Pennisetum purpureum*), but since these and the others have been fully dealt with in a series of articles by Mr. Melle in the "Farmers' Weekly," which have been reprinted and distributed separately, further reference need not be made to them here.

It may be urged that more attention should be paid to the native South African species. It seems rather strange that such a valuable grass as *Chloris gayana* should first meet with the appreciation it desires in Australia, and not in the country of its origin. The great variations in our South African climatic conditions should always be kept in view. For all the drier parts, and the region of winter rainfall the suitability of the various South Western species described above should be considered. It was partly with the object of calling attention to this aspect of the subject that the ecology of *Danthonia purpurea* has been so fully dealt with. Since so many of the grasses with secund false spikes are known to be good grasses, it might be well to investigate the worth of one or two of them about which little is known, *e.g.*, *Ctenium concinnum*. If there is anything in the idea of correlations existing between certain morphological characters and nutritive value, such correlations may be discovered by a careful comparison of various grasses which are known to be valuable.

Soil Erosion. The peculiar topographical and climatic conditions of most of South Africa lead to a relatively rapid rate of soil erosion. Much of it is entirely beyond the control of man, but, as a matter of fact, his influence has been rather to increase it than diminish it. The burning of the grass has very definite effects (1) by sending back the plant succession, and establishing primitive open types of Grassveld, which do

not act as such an efficient protection to the soil as the denser closer climax types; (2) by laying bare the surface of the soil at the time when the first heavy rains fall.

The effects of stock grazing are even more marked, and these are largely increased, if the stock are allowed to roam about at will over unfenced land. The surface layers of the soil are hardened and water does not soak in so readily. Cattle and sheep tracks are formed along which the water runs off, and these gradually deepen, and ultimately form dongas. These drain the rest of the soil, leading to a permanent lowering of the water table and a drying out. Pronounced changes in the veld result usually, once more, in the direction of establishing more primitive xerophytic open types of grassland.

The obvious remedy is to remove, as far as possible, the causes. Burning should be avoided as far as possible, and the stock should be prevented from tramping over the veld to an unnecessary extent. Under present conditions, it is not possible altogether to remove the causes mentioned, and our study of plant succession throws light upon other remedial measures. There are certain plants which are peculiarly adapted to fixing and binding the soil in incipient dongas. Most of those, which are described in the previous section of this work as belonging to the hydrosere, are of this nature. Some introduced species, *e.g.*, *Paspalum dilatatum*, will be found very useful. The stoloniferous species of Sedges, and the spreading rooted or stoloniferous grasses are particularly useful. Everything should be done to encourage their growth, and above all things the vegetation in growing dongas should never be burnt. By the time the donga has deepened into a fairly large ravine trees and shrubs have usually taken possession—a list of the most common species is given above—and denudation has proceeded too far to be checked by grasses and sedges. It may then be caused to silt up by placing obstructions at intervals across it. The plant succession then goes through the various stages of the hydrosere as outlined above, back ultimately to the climax stage of veld. Examples of dongas, which have thus in the past become filled up with alluvial gravels through tree growth blocking the mouth, may be found in Natal, and often in the centre of them denudation has commenced afresh, new dongas cutting their way down through the gravel.

The controlling of the flow of water in various ways helps to prevent dongas from forming, but this aspect of the subject is hardly a botanical question.

Apart from the natural plant succession in dongas, there are several exotic species which have been planted successfully to stop erosion. For certain climates and situations the American Aloe (*Agave mexicana*) is very useful, and for most of Natal there is no better species than the White Poplar which is at the same time a valuable economic timber.

APPENDIX.

LIST OF ENGLISH, DUTCH, ZULU AND SESUTO* NAMES OF GRASSES.

Botanical Name.	English.	Dutch.	Zulu.	Sesuto.
Agropyrum	Wheat Grass			
A. distichum		Suikerriet		
Agrostis	Bent Grass			
A. lachnantha			umHlele	
A. stolonifera	Creeping Bent Grass			
Aira caryophyllea	Silvery Hair Grass			
Ammophila arundinacea	Marram Grass			
Andropogon amplectens			uCebe	
A. appendiculatus		Blauw Gras	isiTshube	Mochela
A. auctus	Tambookie		iPopo, or uQunga	Qokoa
A. ceresiaeformis	Wild Oat Grass		umYakazane	Mobeseletso
A. contortus	Spear Grass	Steek Gras	isiTupe	Selokana

* For the Sesuto names I am indebted chiefly to Dr. Phillips' paper on the flora of Basutoland, for some of the English and Dutch names to Dr. Marloth's "Dictionary of Common Names," and for some of the Zulu names to Bryant's "Zulu Dictionary."

Botanical Name.	English.	Dutch.	Zulu.	Sesuto.
A. cymbarius			uMabobe, or umWamba	
A. dregeanus	Tambookie		uQunga	
A. eucomus			uMafogwane	Mohlaala
A. filipendulus			isiBusana	
A. halepensis	Johnson, or Cuba Grass			
A. hirtus	Blue Grass, or Thatch Grass		inTunga, umNcele, or isiTshimbe	Mookoana oa tsephe, or Mohlomo
A. intermedius			umNcele	
A. nardus var. validus	Tambookie		isiQunga	
A. „ var. marginatus	Kuskus	Akkewani, or Motwortel	isiQunga	Lebata
A. pertusus			imButane	
A. ruprechti			umTsaba	
A. schirensis			umPonjoane	Hloko ea matlapa
A. schoenanthus var. versicolor	Turpentine Grass	Koper Draad Gras		Patiane
A. sorghum var. usorum	Kafir Corn		amaBele	
„ „ var. saccharatus	Shaloo, or Sugar Reed		imFe	Ntsoe
„ „ var.	Sudan Grass			

Botanical Name.	English.	Dutch.	Zulu.	Sesuto.
Anthephora pubescens	Wool Grass	Blauwbuffel		
Anthistiria imberbis	Red Grass	Rooi Gras	inSinde, or inTsinde	Seboku
,, ,, var. glauca	Blue Grass			
Anthoxanthum	Vernal Grass			Lethu
Aristida barbicollis	Wire Grass		nGongoni	Lefiela
A. brevifolia	Toa Grass	T'waa Gras		
A. congesta		Steek Gras		Phutha likhoba
A. junciformis			nGongoni, or imBongani	
A. obtusa	Small Bushman's Grass	Fijne T'waa Gras		
A. uniplumis		Langbeen T'waa		
Arundinaria tesselata	Berg Bamboo	Wilde Bamboes	uQalo	Legala
Arundinella ecklonii			umTshumo	Mahlakamane
Arundo donax	Spanish Reed			
Atropis borreri		Brak Gras		
Avena	Oats			
A. fatua	Wild Oats			

Botanical Name.	English.	Dutch.	Zulu.	Sesuto.
Avenastrum turgidulum			umTepa	Litsa tsa pulumo, or Seboeane
Axonopus semialatus			isiNoza	
Briza maxima	Quaking Grass	Klokkies Gras Tril Gras		
Bromus	Brome Grass	Brom Gras		
B. inermis	Awnless Brome Grass			
B. maximus	Broncho Grass			
B. unioloides	Prairie Grass, or Rescue Grass			
Chloris gayana	Rhodes' Grass		umYaka, or umNyankomo	
Ch. petraea			umBungane	
Ch. virgata	Sweet Hay Grass	Wilde Haver	amaFusine	
Crossotropis grandiglumis			aMahlelane	Yoangba tsela
Cynodon dactylon	Bermuda Quick, Fine Couch, Florida, or Dub-Grass	Fijne Kweek, Kwagga, Oostindiese, or Kruis Gras	isiNandi, umFulwane, or uNgwengwe	Mohloa, or Morara
C. incompletus	Quick Grass	Rechte Kweek Gras		
Cynosurus echinatus	Crested Dog's Tail			
Dactylis glomerata	Cocksfoot			
Dactyloctenium aegyptiacum	Duck Grass, or Coast Grass		isiNandi, or uNgwengwe	

Botanical Names.	English.	Dutch.	Zulu.	Sesuto.
Danthonia elephantina		Olifant's Gras		
D. purpurea	Hare Grass	Haas Gras, or Kwagga Couch		
Digitaria eriantha			isiKonko, or uTepa	Moeane
D. diagonalis			uGoba	
D. sanguinalis	Wild Millet		umFeca	
D. setifolia			Malungale	Lemoko, or Lesale
D. ternata			umFongofongo	Moeane
D. tricholaenoides			umFeka, or umFeca	Mohlaba khama, or Mo-hloea
Ehrharta erecta			umFenyane	
E. villosa		Pijp Gras		
Eleusine indica	Crowfoot, Goosegrass		uMunyankomo, or umNyankomo	Moseli
E. coracana			uPoko	
Elionurus argenteus	Lemon Grass	Wildebeeste Gras, Zuurpol	isiNama, or isiTupe	Hloko
Enneapogon scaber		Zuur Gras		
Eragrostis abyssinica	Teff Grass			
E. aspera			umRrasharrasha	

Botanical Names.	English.	Dutch.	Zulu.	Sesuto.
E. brizoides			umBimbane	LaBaroa
E. caesia				Molulana
E. chaicantha			maTohlwane	Tsane ea lithola
E. chloromelas				Seritsoane ·
E. curvula		Blauwzaad	uViti, or umRrepurrepu	Matolo, or Moseka
E. cyperoides		Steekriet		
E. gummiflua				Thitapoko
E. major			umTimane	
E. nebulosa		Blauwzaad		Tsane
E. plana			umTshiki, or umViti	Molula
E. spinosa	Ostrich Grass	Vogel Struis Gras		
E. superba			uMadolwana, or Qovane	
Erianthus capensis		Ruigte	umTala	
E. sorghum			umTala ga fula, or Mhlope umTala	Mothala
Festuca	Fescue			
F. caprina		Bokbaard		Boleane

Botanical Name.	English.	Dutch.	Zulu.	Sesuto.
F. duriuscula var.	Chewing's Fescue			
F. elatior	Tall Fescue			
F. elatior var. arundinacea	New Zealand Tall Fescue			
F. longipes				Lekoloyane
F. ovina	Sheep's Fescue			
F. pratensis	Meadow Fescue			
F. rubra	Red Fescue			
F. scabra				Serakoe
F. tenuifolia	Slender Fescue			
Fingerhuthia africana		Kalk Gras		
Harpechloa capensis			imBale, or iangama songolole	Marapshane
Holcus lanatus	Yorkshire Fog			
Hordeum murinum	Wild Barley			
H. secalinum		Wilde Garst		Litse bantja
Imperata arundinacea	Bedding Grass Lalang Grass		umTente	Mohlorumo
Koeleria cristata	Crested Koeleria			Boshoane

Botanical Name.	English.	Dutch.	Zulu.	Sesuto.
Lagurus ovatus	Hare's Tail			
Leersia hexandra			maXapozi	
Lolium italicum	Italian Rye Grass			
L. perenne	Rye Grass	Raai Gras		
L. temulentum	Darnel	Drabok		
Melica	Melick			
M. decumbens		Dronk Gras		
M. racemosa			umSetane	
Oplismenus africanus			uBenyane, or umBambalele	
Panicum crus-pavonis			umTimane	
P. hirsutissimum	Buffalo Grass			
P. helopus			isiNandi	
P. isachne			umFisane	Khlolane
P. laevifolium	Buffalo Grass, or Old Land's Grass		uBabe	
P. maximum	Guinea Grass		uBabe, or umYaka Yaka	
P. miliaceum	Indian Buffalo Grass			

Botanical Name.	English.	Dutch.	Zulu.	Sesuto.
P. natalense			uMashanyana	
P. nigropedatum		Krul Gras		
P. serratum			umPentshani	
Paspalum scrobiculatum			isAmuyisane	
Pennisetum cenchroides		Buffel Gras	inTungamusi	
P. longistylum	Kikuyu Grass			
P. purpureum	Elephant Grass, or Napier Fodder			
P. typhoideum	Pearl Millet		Nyaloti, or Nyawoti	Nyalothie
P. thunbergii	Napier's Millet			Lehofe, or Thitapoko
Pentaschistis aeroides				Mafole
Phalaris canariensis	Canary Grass	Kwarrel Gras		
Ph. coerulescens	Toowoomba Canary Grass			
Ph. minor	Small Canary Grass			
Phleum pratense	Timothy Grass			
Phragmites communis	Reed	Fluitjesriet	umHlanga, isiQandolo, umCoboka, iShani, inGqulwane	Lehlaka
Poa annua	Walk Grass			

Botanical Name.	English.	Dutch.	Zulu.	Sesuto.
Poa binata			umQulzazane	
Poa pratensis	Meadow Grass			
Poa trivialis	Rough Stalked Meadow Grass			
Polypogon	Beard Grass		umFomofomo	
Rottboellia compressa				Tayoe, or Namele
Schismus fasciculatus		Haas Gras (Marloth)		
Schmidtia bulbosa	Sand Quick Grass	Zandkweek		
Secale africanum	Wild Rye	Wilde Rog		
Setaria aurea			umFushlo	
S. flabellata				Thusane
S. imberbis			uMakobane	Mofa ntsoe
S. perennis			umYeka	
S. sulcata	Buffalo Grass		uHlongohlongo, or Macopo	
S. verticillata	Bristly Foxtail, or Love Grass	Klis Gras	isiNama	Bohome ba lipoli
Spartina stricta	Cord Grass			
Sporobolus centrifugus				Mabele a linonyana

Botanical Name.	English.	Dutch.	Zulu.	Sesuto.
S. discosporus				Ma motsofali
S. fimbriatus				Matolo a maholo
S. indicus	Dropseed		umSingizane	
Stenotaphrum glabrum	Coarse Couch, or Quick Grass	Grove Kweek	uNgwengwe	
Stiburus alopecuroides			Gangal isigote, or mPongwa	Morakela
Stipa dregeana	Bushman Grass			
Trachypogon polymorphus			isiTupe, or umHesha	Selokana
Tragus racemosus	Carrot-seed Grass			
Tricholaena rosea	Natal Red Top Grass		umKuana, or imBonga	
T. setifolia				Lechocho
Trichopteryx simplex			inSindeboia	
Tristachya leucothrix		Roodezaad	Malandelande	Motsvalle
Triticum	Wheat	Koring	uKolo, or uKolweni	
Urelytrum squarrosum			umFasha	
Any species of Gramineae	Grass	Gras	inCa, or uTshani	

NOTE.—Too great reliance should not be placed on the Zulu or Sesuto names, since different names are used in different districts for the same grass, and on the other hand the same name is often applied to different grasses or to other plants altogether.